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WELLENSTEIN (G.). Ed. **Die Nonne in Ostpreussen (1933–1937). Freilandstudien der Waldstation für Schädlingsbekämpfung in Jagdhaus Rominten.** [The Nun Moth in East Prussia (1933–1937). Field Studies at the Forest Centre for Pest Control in the Rominten Hunting Lodge.]—*Monogr. angew. Ent.* no. 15, xvi+682 pp., illus. Berlin, P. Parey, 1942.

The papers in this symposium were written by observers who, from observation points set up in a coniferous forest in the Rominten district of East Prussia, studied the course of an outbreak of the nun moth [*Lymantria monacha*, L.] that occurred there in 1933–37 [*cf. R.A.E.*, A **24** 750]. The following are abstracts of all the papers except two which have been noticed from an earlier source [**27** 580, 581].

WELLENSTEIN (G.). **Die Bearbeitung der ostpreussischen Nonnenvermehrung (1933–1937) durch die Waldstation für Schädlingsbekämpfung in Jagdhaus Rominten** [Work on the Nun Moth Outbreak in East Prussia (1933–37) at the Forest Centre for Pest Control in the Rominten Hunting Lodge], pp. 1–16, 6 figs., 47 refs. In this introductory paper the author, who was in charge of the investigations in Rominten, reviews the inception and organisation of the project whereby the life-history of *L. monacha* in its natural environment and the epidemiological and ecological aspects of the outbreak were studied over a period of four years, and the efficiency of various control measures was tested. The forest districts of East Prussia affected by the outbreak, which began with a massive flight of adults in the summer of 1933, are shown on a map. Whereas in the pine and mixed forests the outbreak collapsed after one or two years, it became evident in 1934 that the attacks on the spruce forests of Rominten would be severe and prolonged, and the main centre of investigation was accordingly established there. Observation posts were set up at different points in the district, and the moth was studied in all stages of development and at all heights in the trees by means of platforms and scaffolding erected round the trunks.

FISCHER (H.). **Die Massenvermehrung der Nonne in den Staatsforsten des Regierungsbezirkes Gumbinnen 1897–1902** [The Nun Moth Outbreak in the State Forests of the Gumbinnen District, 1897–1902], pp. 17–41, 2 figs., 9 refs. The author reviews the history of *L. monacha* in East Prussia from 1794–98, when it was first recorded in Gumbinnen (the district including Rominten), up to 1937, and attempts to analyse the natural causes of an outbreak that occurred there in 1897–1902 on spruce and pine. From contemporary records he concludes that climatic factors had an important influence on the onset and development of the outbreak; in the years immediately preceding it, unusually high temperature sums with very slight fluctuations were recorded from May to mid-August [*cf.* **21** 114], particularly in June, when the sex organs of the larvae mature, and between late July and mid-August, when the adults are in flight. From 1898 onwards, summer temperatures were low or fluctuating, and only in the warmer, mixed coniferous stands were conditions favourable to the continuance of the infestation. The author also notes that the percentages of females among the total population in one forest were about 80 at the beginning of the outbreak, 60 and 50 in the two following years, and only 15 in 1900. The collapse of the outbreak, which occurred before damage of economic importance had been caused, was evidently brought about by the high mortality of larvae from disease, and to a less extent from parasitism; delays in the development of the individual stages were observed in all the affected districts towards the end of it. The control measures employed, none of which proved particularly effective, included large-scale applications of adhesive bands to the tree-trunks, spraying with Antinonnin (a potassium salt of dinitro-ortho-cresol), and dusting the trees with quick-lime.

MORS (H.). **Die Entwicklung der Nonne im Freiland unter besonderer Berücksichtigung des Klimas und der Frasspflanze** [The Development of the

(726) Wt. P5/3779 9/47 S.E.R. Ltd. Gp. 432. [A]

Nun Moth in the Field with special Reference to Climate and Food-plant], pp. 42–93, 27 figs., 51 refs. Embryonic development of the eggs in autumn lasted 29·5 and 22 days at average temperatures of 14 and 20°C. [57·2 and 68°F.], respectively. The earliest larvae hatched on 30th April (1934) and the latest on 19th May (1935), those high in the tree and on the south side hatching first. Hatching occurred later on young wood and in dense stands than on old wood and in thinner parts of the forest, and mostly in the warmer hours of the day. The larvae remained grouped together for periods ranging from 45 hours at 15°C. [59°F.] to 161 hours at 7°C. [44·6°F.] before dispersing in search of food.

Spruce trees normally begin to develop shoots a few days after the larvae hatch, and the young May shoots are the chief food of the latter; in 1936, which was a flowering year, the leaf buds appeared relatively late, on an average 14·5 days after the larvae hatched, and the flowers, which appeared on an average 9·3 days before the shoots, provided the larvae with an alternative food that was even more nutritious than the May shoots. The simultaneous presence of both flower and leaf buds is thus particularly favourable to larval development. Shoots appeared on the lower parts of the tree on the average 3·3 days earlier than on the higher branches, and there was a difference of up to 17 days in the appearance of shoots on trees in the same stand [*cf.* next abstract].

The rate of larval development is dependent on temperature, and sharp divergences from year to year in the duration of the individual instars are usually levelled out; the whole period of larval development varied only from 51 to 66 days during the four years of the observations. Retarded development and increased mortality of the larvae were observed in 1936 and 1937, particularly in the latter year, indicating a degeneration of the population and the imminent collapse of the outbreak. The prepupal stage lasted 24–130 hours, according to temperature. Pupation normally takes place on the branches or trunks, near the place of feeding, but with increasing infestation greater numbers of larvae pupated in the crowns; pupation occurred in late June or early July and the pupal stage lasted 12·5 days at an average temperature of about 20°C. and 23·5 days at one of 14·4° [57·92]. Males pupated 2–4·6 days earlier than females, and emerged as adults 1·0–1·6 days earlier. The moths emerged between 12th July and 4th August, mostly between 10 a.m. and 6 p.m., and were present for 24–36 days.

The sum of effective temperatures for total development in the field was 18 per cent. lower than that recorded by Zwölfer in the laboratory [**23** 137], because larval development was about 35 per cent. more rapid and the remaining stages slightly longer. When a correction for this was introduced, Zwölfer's method of forecasting the appearance of the individual stages [**23** 137] was found to be fairly accurate.

Mitscherlich (H.) & Wellenstein (G.). **Die Nonne an Früh- und Spättreiberformen der Fichte** [The Nun Moth on early and late Spruces], pp. 94-125, 12 figs., 20 refs. It has frequently been observed during outbreaks of *L. monacha* on spruce that individual trees remain free from attack while others in the same stand are severely damaged [*cf.* **12** 340]. Investigations at Rominten in 1935 and 1936 showed that the intensity of infestation was related to the time of appearance of the young shoots, and that the latter varied on different trees from 20th May to 14th June. The early spruces were the most severely attacked and the late ones the least so, even when, as in 1936, the latter produced abundant flowers and the former very few. The development of the shoots was most advanced and damage most severe in fully stocked stands and on the shorter trees, whereas flowers and cones were most abundant, and larval damage least severe, at the edges of stands and on the tallest trees, where there was most light. Late spruces were better able to recover from infestation than early ones, since their lignified shoots bearing the next year's buds were seldom attacked. Chemical analyses of young shoots and old needles

indicated that early spruces contain less tannic acid and resin than late ones, but there were considerable variations. Field observations showed that larvae that hatch on early spruces find suitable food from the start, whereas those that hatch on late ones do not and migrate to the early ones ; when these are defoliated the half-grown larvae return to the later spruces, on which they complete their development. In cage tests, the mortality of young larvae was less and the amount of frass greater on early than on late spruces, but older larvae showed little difference. Total mortality of larvae could not be clearly related to the food-plant, owing to the occurrence of disease due to overcrowding, and larvae on early spruces proved particularly susceptible to the latter. In a test, in which half-grown larvae that had been reared on oak were transferred to spruce, no great difference was observed in their development on early or late trees or in the fecundity of the resulting females, and it is concluded that the comparative immunity of the late spruces from attack is due merely to the physical inability of the young larvae to feed on hard needles.

Mors (H.). **Aktivität und Frass der Nonnenraupe in den verschiedenen Jahren ihrer Massenvermehrung** [Activity and Feeding of the Nun Moth Larva in the different Years of the Outbreak], pp. 126–175, 21 figs., 44 refs. Newly hatched larvae of *L. monacha* crawl to the top of a tree before beginning to feed [*cf.* **25** 527]. If suitable food is not available there, they descend by means of spun threads to the lower branches, on which the buds open earlier, and defoliate the tree from below upwards. Spinning activity is very slight in the third and fourth instars, after which the larvae tend to crawl downwards. The May shoots of spruce are always preferred to older needles and those in shady positions to the harder ones exposed to the light. Attacks on lignified shoots, which constitute the most wasteful and destructive form of feeding, do not occur until defoliation is complete. In pine stands, all the larvae appear to reach the ground once during their development ; investigations in spruce stands gave inconclusive results, but in lightly infested areas at Rominten only 10–20 per cent. of the larvae did so. At a temperature of about 15°C. [59°F.], newly hatched larvae can climb from the ground to the crown of a tree some 80 ft. high in about 24 hours ; the speed of movement is about doubled with every moult, but is reduced by rain and wind. The amount of food consumed in a day depends on light and temperature. Laboratory tests and field observations showed that the larvae consumed about 80 per cent. of their total food intake during the last two instars ; at an average daily temperature of 15°C., with sharp fluctuations, they consumed more than twice as much as at one of 6·1°C. [42·98°F.], with slight fluctuations. The amount of foliage lost through feeding at the base of the leaves or needles, causing them to drop, was almost twice as great on beech and nearly three times as great on pine as on spruce ; this indicates a special adaptation of *L. monacha* to spruce that probably explains why outbreaks last longer on it than on other trees. Feeding of this type reaches a maximum in the year of collapse of an outbreak, possibly owing to overcrowding.

Mors (H.). **Der Nonnenfalter während einer Massenvermehrung** [The Adult Nun Moth during an Outbreak], pp. 176–206, 11 figs., 40 refs. Field observations at Rominten showed that the percentage of females among the total adult population of *L. monacha* declined from 56 in 1933 to 51, 46 and 26 in the three following years, and to 20 in 1937, when the outbreak collapsed. In the four years 1934–37, the average durations of adult life were 13·5, 10·8, 8·8 and 12·6 days, respectively ; since the average day temperatures for the periods concerned varied only between 16·6 and 18·6°C. [61·88 and 65·48°F], there was little connection between them and survival. There was no difference in the average life of males and females ; pairing shortened the life of the females by about 3 days, but prolonged that of the males. The moths were most active between 9–10 p.m. and 3 a.m. ; day-time activity was slight but increased with temperature. The number of males attracted by unfertilised

females varied in inverse ratio to the intensity of infestation ; the attractiveness of the females was greatest a few days after emergence and declined with age. Mating usually took place when the females were a little over a day old. Each male fertilised an average of 2·7 females in 1934 but only 1 in 1936. Only one of 15 females under observation paired more than once. The average number of eggs per female declined from 218 in 1933 to 127 in 1936 ; fertilised individuals laid 91–96 per cent. of their mature eggs, and 94–97 per cent. of these were viable. Eggs were laid in batches of 35–48 and on all sides of the trunks except those exposed to direct sunlight ; 50 per cent. were laid within about 13 ft. from the ground, and very few higher than 40 ft. Oviposition was heaviest on scaly or lichenous trunks.

These observations indicated a progressive deterioration in the physiological condition of the population that appears to be typical of the declining stages of an insect outbreak. It is attributed to the factors that favour the development of the outbreak, since they cause the survival and reproduction of weaker individuals that would normally succumb, so that the entire population is gradually enfeebled.

Wellenstein (G.). **Zum Massenwechsel der Nonne** [Fluctuations in the Abundance of the Nun Moth], pp. 207–278, 2 col. pls., 14 figs., 119 refs. *L. monacha* is normally most abundant in East Prussia, and least so in Upper Swabia, Saxony, Upper Bavaria and the pine forests of eastern Germany, and outbreaks are thought to occur less frequently in forests with a high residual population than in those with a low one. Outbreaks in spruce forests usually last about seven years, comprising at least four " years of preparation ", two of peak populations and one of collapse, so that a particular stand may be heavily attacked in several consecutive years, whereas an outbreak on pine seldom lasts more than four years, including only one of peak populations. Infestation is spread by wind carriage of young larvae, and by adult flight, which, however, is normally confined to a radius of about 200 yards. Massive adult migrations, which are an indication of overcrowding, occasionally occur in the peak year but seldom affect forests more than 25 miles distant.

Climate, particularly the temperature obtaining during May–August, is the most important factor controlling the onset of an outbreak. High temperatures during July and August favour adult flight, and a late sudden spring is advantageous to the development of young larvae since hatching and the appearance of the young shoots coincide. When these conditions are fulfilled in successive years [*cf.* **19** 328] an outbreak occurs which, in spruce forests, runs its course despite subsequent unfavourable weather. The course of an outbreak is influenced by the quality and quantity of the food available for the larvae, which affect the sex ratio [*cf.* **24** 750] and the fecundity of the females. The mortality of young larvae is higher on pine than on spruce owing to the greater activity and abundance of predators ; mortality of larvae in spruce stands is caused mainly by the Tachinid [*Phorocera silvestris*, R.-D.] and by polyhedral disease, which attacks the larvae with increasing severity from the peak year of the outbreak until its collapse. The disease first broke out in Rominten on 15th July 1935, after 10 days of drought and when temperatures averaged 20°C. [68°F.], and spread more rapidly in the plains than in mountainous districts. It appeared to be favoured by high temperature and moisture. Laboratory experiments showed that mortality was highest in the older larvae and pupae.

The overcrowding that occurs when the larvae begin to defoliate the entire tree leads to physiological disturbance, which in turn causes a decline in the reproductive power of both males and females and earlier mortality of the latter. With the increase in numbers, there is a corresponding increase in the susceptibility of the insect to unfavourable environmental conditions, due to a general deterioration in the physiological constitution of the population.

It has been observed that infestation by *L. monacha* develops more rapidly in some areas than in others ; the areas concerned are usually forests of pine or spruce or both, and the pine stands affected are often those that have recently suffered an outbreak of the pine Noctuid [*Panolis flammea*, Schiff.]. The severity of outbreaks of *L. monacha* on pine has not increased during the last two hundred years, whereas it has more than doubled on spruce, largely owing to the planting of stands of uniform age.

NIKLAS (O.-F.). **Die Lebensweise der Raupenfliege *Parasetigena segregata* Rond. in der Rominter Heide im Hinblick auf eine biologische Bekämpfung der Nonne. Die Parasitierung der Nonne durch Insekten. Teil III** [The Mode of Life of *Phorocera silvestris*, R.-D., in the Rominten Heath District with Regard to Biological Control of the Nun Moth. The Parasitisation of the Nun Moth by Insects. Part III], pp. 359–388, 12 figs., 17 refs. This is a discussion based on the literature and observations at Rominten [*cf.* **27** 580–582] of the value of *Phorocera silvestris*, R.-D. (*Parasetigena segregata*, auct.) in the biological control of *L. monacha*. It is concluded that it is not very great at the centre of attack, where the moth develops most rapidly, but is considerable at the outskirts of outbreak areas. Since the host larvae in these areas are healthier, Tachinid migrations to them are heavier and the mortality of the parasite larvae is lower. While artificial breeding or liberations of the Tachinid are not recommended, a survey of puparia should be carried out whenever an outbreak of the moth is threatened, so that the degree of chemical control required can be estimated.

NIKLAS (O.-F.). **Schlupfwespen und Nonne in der Rominter Heide 1933-1936. Die Parasitierung der Nonne durch Insekten. Teil IV** [Ichneumonids and the Nun Moth in the Rominten Heath District 1933-36. The Parasitisation of the Nun Moth by Insects. Part IV], pp. 389–404, 2 figs., 30 refs. Ichneumonid parasites are seldom abundant enough to be of importance in controlling outbreaks of *L. monacha*. The species recovered from pupae of the moth in Rominten in 1934–36 comprised *Ichneumon* (*Protichneumon*) *disparis*, Poda, *Apechthis compunctor*, L. (*Pimpla brassicariae*, Poda), *A.* (*P.*) *capulifera*, Kriechb., *P. turionellae*, L. (*examinator*, F.), *Ephialtes* (*P.*) *inquisitor*, Scop., *P. instigator*, F., *Itoplectis* (*P.*) *viduata*, Grav., and *Theronia atalantae*, Poda. *I. disparis* was more abundant than all the other species together, but the total percentage parasitism by all the Ichneumonids averaged only 1·1, 1·5, 0·5 and 0·3 in the successive years from 1933 to 1936, and they were only four times as abundant in the areas most heavily infested by *L. monacha* as in those very lightly attacked. They are apparently not specific to any one host, and all have similar life-histories. Eggs are laid on pupae, preferably females, and also on full-fed larvae ; larval development proceeds within the host pupa, and the adults are in flight from late April until October and overwinter in the open, in various sheltered places.

STEINFATT (O.). **Die Beziehungen zwischen Vogelwelt und Nonne in der Rominter Heide anlässlich der letzten Massenvermehrung** [The Relationship between the Bird Life and the Nun Moth in the Rominten Heath District during the recent Outbreak], pp. 405–477, 8 figs., 38 refs. The author enumerates 18 species of birds, mostly Passerines, that were more or less constantly predacious on the larvae, pupae and adults of *L. monacha* in Rominten, and discusses from direct observations and analyses of stomach contents the degree of control afforded by each. The tall spruce trees of Rominten, bare of branches for nearly two-thirds of their height, offer few or no nesting facilities for birds, which may be one of the reasons why outbreaks of *L. monacha* proceed almost unchecked in this region ; on the margin of the main centres of attack, however, birds were observed to be particularly useful in preventing the further spread of infestation, especially as they did not feed to any comparable extent on the insect parasites of the moth. In coniferous stands liable to severe attack by *L. monacha*, birds should be encouraged by the provision of artificial nesting

places and by suitable forest management, including the planting of deciduous trees in the larger gaps.

WELLENSTEIN (G.). **Überwachung der Nonne und Vorhersage ihrer Massenvermehrung** [Surveying the Nun Moth Population and predicting Outbreaks], pp. 478–534, 1 col. pl., 23 figs., 44 refs. This detailed critical study of methods of assessing the population of *L. monacha* and predicting outbreaks includes an account of a new method, based on counts of pupal cases, that was evolved by the author and tested at Rominten. The counting of adult moths is the simplest and most economical method of assessing the general intensity of infestation. It should be instituted at the onset of an outbreak in all coniferous stands more than 40 years old and should continue from 1st July until about mid-August, when adult flight has ceased. Selected trees should be inspected every three days and counts made of the number of moths present on the trunks up to a height of about 10 ft.; males and females should be counted separately in view of the progressive decline in the proportion of females during outbreaks. Comparison of the totals obtained in stands of pine and spruce in the last of the "years of preparation" with the amount of damage that ensued in the following year showed that counts of 8–15 females per pine tree were followed by severe damage, while counts of 20–28 females per spruce tree were followed by 50–75 per cent. defoliation. Less than 3 females per pine or 11 per spruce did not constitute a danger.

Estimates based on the number and weight of pupae [*cf.* **22** 611] are unreliable because of the very uneven development of the stages during an outbreak and the varying mortality due to natural enemies, but excellent results were given by counting and measuring pupal cases after the end of the adult flight [*cf.* **24** 750], which took account of the whole adult population, pupal mortality and the probable fecundity of the females and allowed population forecasts to be made for at least two years ahead. The pupae are fairly evenly distributed over the trees, in moderately heavy infestations; on spruce the pupal cases, which are very light, remain firmly attached to the trees unless defoliation is severe, but on pine the pupae in the crowns usually fall to the ground before the adults emerge, so that the ground round the trees should also be searched. Sample trunks evenly distributed throughout the area of infestation should be felled, and all the insect remains, at any stage of development, dead or alive, should be collected and sorted. The pupal cases of females should be separated from those of males; they can be distinguished from them by differences in shape and size, which are described and figured, and their measurements serve as an indication of the egg-production of the females. Practical experience in spruce stands showed that an average of 25 female cases per trunk corresponded to an average of 4,375 eggs and 65 per cent. defoliation in the following year, which was well in accordance with the results obtained by counting adults. Since the counting and classification of pupal cases takes 3–4 times as long as that of adults, it should be carried out only when previous adult counts show at least five females per tree.

Other methods of estimating populations, which are discussed and considered unreliable or less satisfactory, include counts of eggs, of newly hatched larvae found below bands placed on selected trees, of larvae that have begun feeding, and of male moths attracted by the scent of captive females. It is concluded that in forests liable to attack by *L. monacha*, counts of adults by the method described should be undertaken every year; when it is thought that an outbreak is imminent, a count of the pupal cases should be carried out, which will enable estimates to be made of the degree of infestation likely to occur for several years ahead and of the amount of control that will be necessary.

MORS (H.). **Untersuchungen zur Nonnenprognose Wellensteins und die Bedeutung gradologischer Merkmale** [Investigations on Wellenstein's Method of forecasting Nun Moth Abundance, and the Importance of Outbreak Indices], pp. 535–553, 9 figs., 29 refs. Investigations at Rominten showed that the

method of estimating the egg-production of *L. monacha* by means of the weight of the female pupae [**22** 611] was unreliable, since it was difficult to distinguish living pupae from dead ones, the average weight of the pupae increased as the date of pupation advanced, and the weight of individual pupae decreased by 20–40 per cent. as the pupal stage proceeded. The relation between pupal weight and egg-production varied from year to year. The mean of the diameters of the two abdominal segments immediately posterior to the tips of the wing cases on the empty pupal skins was therefore substituted and was found to be directly related to egg-production, though the coefficient of correlation fell from 0·85 in 1934 to 0·43 in 1937, owing to variations in egg-production in different years by individuals of comparable size. The relation could be expressed as an exponential curve, which tended to flatten out as the outbreak progressed. It is suggested that this correlation and the coefficient of regression might be used to indicate the progress of an outbreak, together with such other factors as the sex ratio, the duration of adult life, the generative power of the males and the egg-production of the females, and curves are given to illustrate the relation between size of pupal case and number of eggs at the beginning, the peak and the collapse of an outbreak.

Wellenstein (G.). **Vier Jahre Nonnenbekämpfung in Ostpreussen** [Four Years of Nun Moth Control in East Prussia], pp. 554–604, 18 figs., 4 maps, 53 refs. The control measures carried out against the larvae of *L. monacha* at Rominten in 1934–37 consisted chiefly of treatments with proprietary dusts containing arsenicals or dinitro-ortho-cresol, applied at various dosages from power dusting machines on the ground and also, to an increasing extent, from aeroplanes. The areas treated, the quantities used and the manner of application are shown in tables. Preliminary field experiments in 1934 showed that various proprietary contact insecticides, including pyrethrum, were quite ineffective as a substitute for calcium arsenate and that arsenical dusts, even at 90 lb. per acre, were likely to be effective in the first peak year of an outbreak on spruce only when counts of pupal cases showed not more than 300 females per trunk ; areas that were dusted in 1934 and left untreated in 1935 were completely defoliated. The fear that insecticidal treatments might have an invigorating effect on the insect population by eliminating the weaker individuals was found to be groundless, since the larvae that survived treatment were more or less affected by it and their progeny of the next generation showed increased mortality.

Laboratory experiments having shown that both rotenone and pyrethrum were practically useless against *L. monacha*, field tests were carried out in 1935 in which Detal, a new contact dust [containing dinitro-o-cresol] that had been found very effective in preliminary tests against the larvae [*cf.* **24** 517], was applied from aircraft to spruce trees 80 years old. Three applications made on the evening of 3rd June and on the mornings of 4th and 9th June, totalling 58·5 lb. per acre, gave at least 98 per cent. kill of young larvae ; and dosages totalling 45 lb. per acre applied on 7th–10th June, and a dosage of 72 lb. per acre on 22nd June, gave averages of 65 and 76 per cent. mortality, respectively. The risk of injury to spruce needles by Detal was investigated in October, when 135 lb. dust per acre was applied from the ground ; no damage was observed in these or in further tests carried out in the following summer, although in one spruce forest severe damage to May shoots was reported in September 1941 following an application of 108 lb. Detal per acre in June.

In laboratory tests in the winter of 1935–36, when young larvae kept at optimum temperature and humidity were dusted with proprietary contact insecticides, 10 per cent. Detal gave the best control in every case. Further tests with Detal and other proprietary dusts showed that the rate of application was more important than the concentration of the dust ; mortality was not affected by temperature, but increased in low humidity ; the resistance of the larvae increased with age ; and larvae about to moult were more resistant than

others. Despite their high toxicity, the coarse texture of these dusts rendered them less suitable for application than arsenicals. The problem of ascertaining a dosage that would give adequate control in dense spruce stands without injury to deer or other animal or plant life is discussed; one of 72–90 lb. calcium arsenate or 45–72 lb. Detal per acre was thought likely to be the most satisfactory. Further field tests carried out in 1936 showed that for a given amount of insecticide, a single application of dust was more effective than repeated smaller applications.

It is concluded from the whole work that dusting should be carried out as quickly as possible when 90 per cent. of the larvae have reached the crowns of the trees, that a dosage of at least 90 lb. per acre is required to give adequate control, that areas should be treated for at least two consecutive years, and that control should be begun in the fourth year of preparation of the outbreak at the latest. In a discussion of the relative merits of dusting from the air and from the ground, it is stated that owing to their great height and the effects of air currents, the crowns of spruce trees could not always be reached by dusts applied from ground level. Applications from the air, however, were more successful, and the dust cloud settled fairly evenly over the trees. Treatment was best carried out by aircraft operating singly. Tables are given showing the influence of the distance from the airfield and the shape and distribution of the areas to be treated on the performance of various types of aeroplanes, which are compared. A method of estimating the mortality of the larvae by comparing the amount of excreta found after treatment with the population as estimated by the numbers of pupal cases is described.

Reier (J.). **Die Entwicklung der Flugzeugbekämpfung in technischer Hinsicht** [Technical Aspects of the Development of Insect Control from Aircraft], pp. 605–630, 14 figs., 39 refs. The history of the use of aircraft for the application of insecticidal dusts to forest areas is reviewed, and various types of dusting equipment that have been evolved in Germany for this purpose are described and figured. Experience has shown that the apparatus must be constructed in such a way as to emit a fine, even cloud of dust that sinks rapidly on to the trees, penetrating them in an almost vertical direction; it must be easily regulated and controlled, and free from leakage of dust. Technical details are given of the construction of suitable apparatus. To be effective, it should release the dust at the rate of about 7–20 lb. per second from an aircraft travelling at nearly 70 miles an hour, forming a cloud about 80 ft. wide and giving a rate of application of about 36–108 lb. per acre. Tables show the performance of the types of aircraft used in 1936.

Wellenstein (G.). **Zur Frage der Kennzeichnung von Flugfeldern bei der Forstbestäubung** [On the Question of marking out Forest Areas to be dusted from Aircraft], pp. 631–644, 8 figs, 8 refs. The hydrogen-filled rubber balloons used at Rominten for marking out the areas to be dusted from aircraft did not prove particularly satisfactory, and the author subsequently devised and here describes balloons of a new type, made of a rubberised cotton material and filled with hydrogen, which when floated a few feet above the tops of the trees were clearly visible from the air. They were less sensitive to changes in temperature and humidity than the rubber ones, and less subject to damage by impact with the trees.

Niklas (O.-F.). **Die Wirkung der Nonnenbegiftung auf die Kerbtierwelt** [The Effect on the Insect Fauna of Poisons used against the Nun Moth], pp. 645–658, 4 figs., 15 refs. The stomach and contact poisons used at Rominten in 1934–36 against *L. monacha* caused considerable injury to nearly all the other species of insects present in the crowns of the trees, though not all suffered to the same extent. In 1935, 65 per cent. of the colonies of honey bees in the neighbourhood of stands dusted with arsenicals were destroyed; in 1936, however, when the bees were removed to a safe distance during dusting operations, no injury was caused. Dusts containing dinitro-o-cresol were not noticeably

injurious to the bees. A certain amount of damage resulted from the leakage of arsenical dust from the apparatus in the aircraft. The action of the dusts on adults of *Phorocera silvestris*, R.-D. (*Parasetigena segregata*, auct.) was tested in the laboratory; varying degrees of mortality were observed, the stomach poisons proving the least injurious. In the field, it was found that adult flights declined in intensity after dusting, and the decline was most marked when the time of dusting most nearly coincided with the maximum flight period, between 20th May and 4th June.

Steinfatt (O.) & Wellenstein (G.). **Folgeerscheinungen der Giftbestäubung auf die höheren Tiere und die Pflanzenwelt** [The Consequences to higher Animals and Plants of the Use of poisonous Dusts], pp. 659–681, 34 refs. The widespread use at Rominten of large quantities of dusts containing calcium arsenate or dinitro-o-cresol caused few cases of illness in man. Some arsenical poisoning occurred in grazing cattle and in birds, but deer were relatively unaffected; four cows had to be slaughtered and others gave no milk for a period of four weeks. Dusts containing 12–17 per cent. calcium arsenate applied at more than 45 lb. per acre caused a great increase in bird mortality, but did not injure plants. Dusts containing dinitro-o-cresol caused no appreciable injury to higher animals, even at high concentrations, but sometimes scorched coniferous trees and occasionally defoliated larch and shade trees. Vegetable crops near dusted areas, especially beet and crucifers, were severely damaged, but cereals were not much affected. The authors conclude that both types of dust are dangerous when used at more than 45 lb. per acre.

Queensland. Annual Report(s) of the Department of Agriculture and Stock for the Year(s) 1943–44, 1944–45, 1945–46.—34, 40, 88 pp. Brisbane, 1944, 1945, 1946.

Notes on entomological investigations in Queensland during the years 1943–44, 1944–45 and 1945–46 are given in the Report of the Director of Plant Industry (Research) by R. Veitch (pp. 5–10), the Report of the Officer-in-Charge, Science Branch, by J. H. Smith (pp. 12–17) and the Report of the Entomology Section by J. H. Smith (pp. 22–26), respectively.

Studies on the protection of stored potato tubers from *Gnorimoschema operculella*, Zell., by means of dusts [*R.A.E.*, A **33** 31] were concluded in southern Queensland during 1943–44, when tubers from the spring crop were treated with a derris dust containing 1 per cent. rotenone, a dust containing 5 per cent. pyridine, magnesite or a commercial organic mercurial preparation and stored under farm conditions for three months. The derris dust gave almost complete protection and prevented the development of larvae that entered the tubers during the interval of up to 24 hours that elapsed between lifting and treatment. Magnesite and pyridine were also satisfactory, but probably no more so during the wet summer months than the practice of lifting the tubers promptly and storing them under a thick, weighted layer of straw. The mercury preparation was of little value. In the following year, magnesite gave good protection in northern Queensland, where the tubers are harvested during the dry weather of late winter and early spring. Indications were obtained in 1943–44 that the stems of irrigated spring crops do not become infested to any extent and that leaf-mining may be extensive but does not materially influence the yield. Dusts containing 1 or 2 per cent. DDT applied to heavily infested potato plants two weeks prior to harvest in 1944–45 were not very effective against the larvae in the leaves. In 1945, many non-irrigated spring crops in southern Queensland were completely destroyed as a result of infestation; damage to the haulms of irrigated crops was of little importance, but large numbers of tubers were unmarketable, and bagged tubers that were not treated with protective dusts before storage deteriorated rapidly. Derris and DDT, which was toxic in preliminary spraying tests to larvae mining in the leaves,

were applied to potato plants under experimental conditions at weekly or fortnightly intervals during the month prior to harvesting in an attempt to prevent damage to the haulm and reduce infestation of the tubers, but the crop matured during a period of considerable moth activity, and none of the schedules reduced wastage among the tubers to a commercially unimportant level. In a varietal trial in 1944–45, the damage to tubers from plants of six different varieties varied from four to 22 per cent. *G. operculella* is a major pest of tobacco seedlings and plants in North Queensland, where it reduces the quality of the leaves and, under unfavourable weather conditions, may kill young plants. In experiments in 1945–46, sprays containing 0·1 and 0·2 per cent. DDT applied at fortnightly intervals for a month after transplanting gave good control and dusts containing 1 and 2 per cent. DDT were also effective; the protection conferred continued for another month until there was no further risk of serious injury.

Plutella maculipennis, Curt., was active on cabbage crops during 1944–45, when the effectiveness of sprays and dusts containing lead arsenate or derris was reduced by showery weather during the growing period. Sprays and dusts containing DDT applied to infested cauliflowers gave complete control of the larvae within a few days, and the plants remained uninfested for at least three weeks; two applications gave complete protection. This moth was again abundant in the winter and spring of 1945, although large numbers of larvae were destroyed by entomogenous fungi. A combined dust of derris and nicotine sulphate diluted with hydrated lime is frequently used to control *P. maculipennis* and *Brevicoryne brassicae*, L., on cabbage, but it was thought that the lime, which activates the nicotine sulphate, may reduce the effectiveness of the derris. An experiment indicated that dusts of derris alone were more effective against *P. maculipennis* than combined dusts containing the same amount of derris, and their use is therefore recommended, additional applications of nicotine sulphate being made when Aphid infestation renders them necessary. In comparative tests in 1945–46, two applications of sprays containing 0·1 per cent. DDT and three of a dust containing 2 per cent. DDT both gave good control of *P. maculipennis* and *Hellula* (*Oebia*) *undalis*, F., on cabbage. The test also indicated that the more important commercial emulsions of DDT are of equal value per unit of DDT and that differences in the effectiveness of impregnated and pan-mill dusts are negligible in practice. *Apanteles glomeratus*, L., the introduced parasite of the cabbage white butterfly [*Pieris rapae*, L.], was liberated at two places in 1943–44 [*cf.* **33** 322]. *P. rapae* had spread to most of the vegetable-producing areas of southern Queensland by 1944–45, and *Crocidolomia binotalis*, Zell., was important on cruciferous crops in central and northern Queensland in that year.

In the course of experiments with DDT against vegetable pests in 1944–45, a 2 per cent. dust and a 0·2 per cent. spray applied six weeks before harvest to beet heavily infested with *Hymenia recurvalis*, F., gave complete control, whereas the larvae completely destroyed the foliage of plants that were dusted with 1 per cent. rotenone or 50 per cent. cryolite. Dusts containing 1 or 2 per cent. DDT had not reduced adult populations of *Thrips tabaci*, Lind., on cucumber by the end of a fortnight, but nymphs were less numerous after that period, and it is thought that the rate of reproduction had been reduced. They did not control *Tetranychus telarius*, L. (*urticae*, Koch) on cucumber, but did not cause any increase in its numbers. The 2 per cent. dust and the 0·2 per cent. spray gave excellent control of a heavy infestation of *Agromyza phaseoli*, Coq., on beans; oviposition was not inhibited, but few eggs hatched and very few larvae survived. These results were confirmed in the following year in field tests of DDT and the spray of nicotine sulphate and white oil in general use, which is satisfactory provided that applications are carefully timed. The applications were made at intervals of 3, 4, 3, 4 and 3 days or 3, 7 and 7 days, and fewer plants survived in the untreated than in the treated plots. The

2 per cent. DDT dust was more effective than the nicotine sulphate when applied according to the first timing schedule, and a spray containing 0·1 per cent. DDT had more residual effect than the dust and so was effective when applied according to the second. When germination is irregular, however, the 3–7–7 day schedule may permit larvae that hatch from eggs laid in the interval between the first and second sprays to reach the base of the stem, and a schedule of 3, 4, 7 and 7 days is therefore recommended ; a DDT spray applied at these intervals gave satisfactory results on several occasions. *Nezara viridula*, L., was more injurious than usual in the summer of 1943–44, but in autumn many egg-masses were found to be attacked by two parasites, of which *Microphanurus basalis*, Woll., introduced from Western Australia some years previously [**25** 322], was the more important. In 1944–45, however, overwintered adults were very numerous, and tomatos were commonly infested. Dusts containing 1 and 2 per cent. DDT and sprays containing 0·1 and 0·2 per cent. DDT gave good control on tomato plants from which the first picking was unmarketable ; the sprays were superior to the dusts. Several dead adults of *Lygaeus hospes*, F., which is also a pest of tomatos, were found in the treated plots.

The effectiveness of lead arsenate in an inert carrier or in combined dusts against *Aulacophora* (*Rhaphidopalpa*) *abdominalis*, F., and *A.* (*Ceratia*) *hilaris*, Boisd., on rock melon and cucumber was investigated in field trials in 1944–45. All the dusts reduced adult populations to a low level for at least five days, after which the beetles again became evenly distributed throughout the plots ; lead-arsenate sprays were less effective. Insecticides used against these beetles should be repellent as well as toxic, especially on spring crops, where the over-wintered adults can cause considerable damage to the germinating seedlings before poisons can take effect. On plants dusted with lead arsenate, the beetles congregate on young shoots that have developed since the treatment. Combined dusts with a blue tinge were less effective than dusts containing the same amount of lead arsenate alone in a white carrier. A dust containing 25 per cent. lead arsenate is both toxic and repellent and can be used on very young plants at weekly intervals. The beetles are rarely sufficiently numerous on flowering and fruiting plants to cause serious damage. Other insects recorded on vegetable crops during 1944–45 were *Zizera* (*Zizeeria*) *labradus*, Godt., which damaged French beans in spring, *Sybra centurio*, Pasc., the larvae of which mine the stems of soy beans, and *Thrips tabaci*, which prevented seed formation in onions in one district. During 1945–46, *Phyllotreta australis*, Blkb., was abundant on turnip at one place, larvae of another Halticid, *Xenidea picticornis*, Blkb., were found on potato in an area in which they had not previously been observed, *Dichocrocis punctiferalis*, Gn., infested the pods and stems of soy bean in late summer, and *Empoasca terrae-reginae*, Paoli, severely infested solanaceous crops in southern Queensland.

The use of insecticides against *Empoasca maculata*, Evans, which is a major pest of cotton, especially when the crop matures late, has not been economic owing to the large numbers of applications required. The value of a dust containing 2 per cent. DDT was tested in 1944–45, and weekly applications prevented nymphal development from proceeding very far, though they did not prevent oviposition. In work in 1943–44 on the development of Jassid-resistant strains and varieties of cotton, a mass-selected strain of the Miller variety was partially resistant when used on a commercial scale. Very promising strains were obtained among 200 hybrids and 100 pure selections from this variety, and work on the development of resistant strains of other important commercial varieties was begun. The results obtained in 1944–45 are given in the Report of the Specialist Adviser, Experiment Stations, and Cotton Specialist, by W. G. Wells (pp. 10–12). A highly resistant strain of the Miller variety that had given good results in small-scale experiments was made available for commercial use and gave high yields despite drought conditions ; further reselections

showed an improvement in the length of lint produced. Most of the more advanced strains and hybrids of Miller cotton were found to be more resistant than a commercial stock of this variety. In a similar report for 1945-46, Wells (pp. 18–21) states that new resistant strains of the Miller variety with improved agronomic qualities were tested, and hybrids of the three other commercial varieties under experiment showed high resistance.

In an experiment on the control of *Heliothis armigera*, Hb., on cotton in an irrigated area in 1943–44, the yields of seed cotton from October plantings were increased by a dust containing 90 per cent. lead arsenate, but not by a spray of 1 lb. lead arsenate and 1 gal. molasses in 6 gals. water. In the following year, three applications of the dust or of a spray in which the amount of lead arsenate was increased to 2 lb., made at four-day intervals while oviposition was at a peak in early January, were followed by increased yields during the first picking, but not during the second. Aphid attack was later heavy on the treated plots, especially the sprayed ones. A 2 per cent. DDT dust applied during the peak of adult activity did not reduce the number of eggs laid on the terminals, the amount of damage to the squares or the number of larvae present per 100 squares. In experiments in 1945–46 in another part of the State, where *H. armigera* was not very numerous and insecticides were applied only in January, sprays and dusts containing DDT and dusts of lead arsenate reduced the damage to squares, DDT being the more effective material. In 1944–45, oviposition peaks occurred in mid-November, mid-December and early and late January, but although the last three coincided with the formation of the squares, only the one in early January was followed by appreciable injury. The peak oviposition periods can be detected by means of egg counts, the data from which are applicable over a whole district. The crops can be protected by applying insecticides during these periods, since the larvae acquire a lethal dose before causing much damage, but lead arsenate is seldom sufficiently toxic for this purpose. Drought conditions during the middle of the season induced swale effects in all areas except those that were irrigated, and in these swales plant growth was vigorous and eggs were deposited over a comparatively long period, indicating that ovipositing females exercise a fair amount of selection. In view of this, the extent to which oviposition varies on tomatos according to the cultural system adopted was investigated in a coastal area in the spring of 1945, when the mean number of eggs per terminal shoot in October was as high as 20. Active oviposition continued for about eight weeks, and considerably more eggs were laid on bush tomatos than on staked, trellised or cradle-grown plants.

Flowering heads of sorghum that are enclosed in paper bags shortly before the appearance of the stamens to prevent cross-pollination are generally very heavily infested by *H. armigera*, since the larvae that hatch from eggs deposited before the heads are enclosed are protected from natural enemies. In a test in 1944–45, heads that were dusted with 1 per cent. DDT before being enclosed were free from injury when the bags were removed three weeks later; a dust containing 50 per cent. lead arsenate gave fair protection, and untreated heads were almost all seriously damaged. Dusts and sprays containing 2 and 0·2 per cent. DDT, respectively, gave almost complete protection from *Contarinia sorghicola*, Coq., in an infestation that destroyed unprotected heads. In a field test in the following season, considerably fewer adults emerged from sorghum treated at the beginning of the flowering period with dusts containing 1 or 2 per cent. DDT than from untreated heads; the two dusts were equally effective. Evidence was also obtained that oviposition is not confined to the period after the spikelets open, as had been believed [*cf.* **30** 499], since large numbers of adults emerged from spikelets that were enclosed in bags before the extrusion of the stamens; insecticides should therefore be applied earlier than hitherto recommended. Some damage to wheat in one district was caused by adults of the Melolonthid, *Othnonius batesi*, Oliff, in 1945–46.

Stored maize is infested by the rice weevil [*Calandra oryzae*, L.] to a greater extent than stored wheat in Queensland, and in view of the satisfactory protection afforded to the latter by magnesite [*cf.* **33** 372], the possibility of using inert dusts on maize was tested in 1943–44. Maize treated with magnesite, copper carbonate and copper oxychloride showed little or no deterioration after three months, and damage in that treated with dolomite was only slight; appreciable damage occurred in maize treated with hydrated lime, and infestation was as high as 80 per cent. in untreated maize. In a similar test in which the dusts were used to protect stored French beans against Bruchids [*cf.* **35** 35], only the two copper dusts and dolomite gave effective control; 90 per cent. of the seeds treated with them were found to be viable.

Activity by the yellow-winged locust [*Gastrimargus musicus*, F.] in southern Queensland increased during the three years prior to 1943–44, and in that year it invaded sub-coastal areas in central and northern Queensland, where climatic conditions are somewhat similar. Many hoppers hatched during the spring, and large-scale migrations to the wetter coastal regions occurred during the summer, when the locusts caused appreciable damage to sugar-cane, maize and pastures. Egg-parasites were active towards autumn. In 1944–45, hopper swarms of considerable density occurred in the Burdekin district in spring and early summer, but there was little damage farther south. Swarms of adults were less dense than in the previous year and did not persist, and there were fewer egg-beds in the autumn. In 1945–46, the hoppers that hatched in spring were of little importance, but the adults later caused considerable damage to maize and other crops. Eggs were again laid in autumn, and some of them showed signs of parasitism by *Scelio bipartitus*, Kieff. A dust containing 2 per cent. DDT applied at a rate of about 34 lb. per acre gave 80 per cent. mortality of hoppers. *Austracris guttulosa*, Wlk., caused some damage to fodder crops in central and southern Queensland in 1944–45. Adult swarms were numerous in summer and attacked maize, sorghum, cotton and *Citrus*.

Aonidiella aurantii, Mask., increased in injuriousness to *Citrus* in sub-coastal areas in 1944–45, owing partly to favourable weather conditions and partly to insufficient fumigation in winter. *Biprorulus bibax*, Bredd. [*cf.* **20** 163] normally migrates to *Citrus* in spring and early summer in sub-coastal districts, and control measures are not generally required after January. In 1946, however, migration continued until February and March, when conditions were unfavourable for fumigation and losses to lemon, which is the preferred foodplant, were heavy in some orchards. Sprays containing 0·1 or 0·2 per cent. DDT and DDT dusts were tested against this Pentatomid during the outbreak and against *Rhoecocoris sulciventris*, Stål, in spring, and the sprays were effective against both, whereas the dusts were of little value. *R. sulciventris* is normally controlled on *Citrus* by means of sprays containing derris or a mixture of resin, caustic soda and fish oil applied during autumn or winter, but its presence may not be noticed then, and these sprays are not very effective in spring and early summer, when both nymphs and adults appear. Larvae of the Noctuid, *Tiracola plagiata*, Wlk., which was last of importance in 1927 [**16** 223], appeared in large numbers in March 1945 on native bryony [*Bryonia laciniosa*], from which they migrated to banana and made large holes in the pseudostems and attacked the throats of the suckers and small plants. They were effectively controlled by a poison bait containing Paris green and bran applied to the plants and the ground. *Scirtothrips signipennis*, Bagn., infested a few banana plantations in 1944–45, and in the following year caused damage in most plantations in southern Queensland. The bunch covers hitherto recommended [**26** 211] to prevent the thrips from reaching the fruit are not easily placed in position on the taller variety now generally grown, and experiments were carried out in North Queensland to determine the value of DDT dusts applied to the fruit in summer, when infestation is highest. One containing 2 per cent. DDT caused a gradual decline in populations, which remained low for at least two weeks.

In experiments against *Cydia pomonella*, L., on apple in 1945–46, baits containing oil of sassafras or oil of mace, renewed every fortnight, were as effective in indicating the trend of activity as the standard wine bait; both trapped more moths than the wine bait and may therefore be more useful in late summer when populations are relatively low. On apple trees that had received a calyx spray of lead arsenate, cover sprays containing 0·1 per cent. DDT were as effective against *C. pomonella* as those containing insecticides at present recommended. *Bryobia praetiosa*, Koch, and *Eriosoma lanigerum*, Hsm., both became numerous and injurious on trees treated with them, and *Tetranychus telarius*, which does not normally occur on deciduous fruits, also became common. In these experiments and those on the control of *Biprorulus bibax* by means of DDT, dead adults of *Dacus (Strumeta) ferrugineus tryoni*, Frogg., were common beneath the sprayed trees and fruit-fly damage was less severe on them than on the controls; in the *Citrus* orchards, there was a marked decline in the numbers taken in bait-traps after each application, and the population remained low for at least two weeks. In preliminary investigations in 1944–45 on the possible transmission of plant-disease organisms by *D. f. tryoni*, bacteria were found within surface-sterilised puparia and adults, but the organisms isolated gave negative results when inoculated into *Citrus* fruits.

It is stated in the third report that a Scolytid recorded in a number of orchards, chiefly apple and plum, throughout the Granite Belt during 1944–46 may have been responsible for the death of these and other fruit trees. The first indication of infestation is given by the sudden collapse of the foliage on a single limb or on the whole tree. The brood chambers are situated well within the wood, and the galleries may be numerous; dark brown lesions extend along the trunk or limb from each brood chamber for a considerable distance, and it is thought that a disease organism may be introduced by the beetle. The cultivation of *Macadamia* nuts in southern Queensland has in recent years been hampered by *Homoeosoma vagella*, Zell. The eggs are laid in the flower spike, and the larvae enter and feed on the flower buds. Most of them pupate in the débris on the ground beneath the tree, but some do so among the flowers. In view of the increasing interest in the control of this Pyralid by means of insecticides, especially on *M. ternifolia*, which flowers over a period of about six weeks, tests were made with sprays containing DDT and lead arsenate. Both gave effective control when applied at intervals of 14 days from the beginning of the flowering period.

Other fruit pests recorded during 1945–46 include the mite, *Tenuipalpus californicus*, Banks, which is established on passion vine [*Passiflora edulis*] in most coastal and sub-coastal areas and of which heavy infestations occurred in two districts; the gall-wasp, *Eurytoma fellis*, Gir., which was commoner on *Citrus* than usual and almost completely destroyed young trees in recently established orchards on the north coast; *Margaronia tolumnalis*, Wlk., the larvae of which injured the leaves of fig at one place; and *Howardia biclavis*, Comst., which caused some damage in moderately infested orchards of custard apple [*Annona*]. In 1944–45, the Buprestid, *Cisseis* (*Neospades*) *chrysopygia*, Germ., attacked the flowers and young fruits of strawberry.

In many parts of Queensland, oil sprays are little used because adequate supplies of soft water are not available for the preparation of emulsions. In some districts, both underground and surface waters contain relatively large quantities of magnesium salts, which render the emulsions unstable, but in experiments in 1944–45, good emulsions of commercial oil concentrates were prepared with such water by adding sodium hexametaphosphate or trisodium phosphate to it at the rate of 2 oz. per 100 gals.

Experiments on soil treatment with lead arsenate against larvae of the Melolonthid, *Rhopaea magnicornis*, Blkb., damaging seedlings of hoop pine [*Araucaria cunninghami*] had been in progress for two years in 1945–46. They showed that the seedlings are more tolerant of the treatment than was formerly

supposed, and applications of from 10 to 50 lb. lead arsenate per 1,000 sq. ft., mixed with sawdust, almost completely protected the seedlings for as long as they remained in the seed beds. In continued investigations in 1943–44 on the cause of losses in plantations of *Araucaria* [*cf.* **33** 32], evidence was obtained that a plant pathogen is the primary causal factor and that the two insects associated with dead and dying trees normally attack only unhealthy plants ; in the absence of insect infestation, however, the trees would probably recover. One of the insects was also found in areas where logging of *Pinus radiata* had begun, and since this pine is attacked by a number of native boring insects prompt handling of the felled timber is essential. The same is true of brown tulip oak [*Tarrietia argyrodendron*], which is susceptible to weevil infestation if left in the scrub after felling. Other insects recorded in forestry work in 1945–46 were *Quadraspidiotus* (*Aspidiotus*) *perniciosus*, Comst., which infested white gum [*Eucalyptus*] in central Queensland, *Euxoa radians*, Gn., which attacked seedlings of *Araucaria* in a forest nursery in December and destroyed the cotyledons and shoots, sometimes to below ground level, and Cicadids of the genus *Melampsalta*, which were so numerous in one area that large *Eucalyptus* trees were killed by their oviposition punctures.

An investigation of the possibility of reducing the susceptibility of sapwood from the red tulip oak [*Tarrietia argyrodendron* var. *peralata*] to attack by *Lyctus brunneus*, Steph., by removing a strip of bark right round the tree at the top of the commercial bole some months before felling in order to reduce the starch content is described in the report for 1944–45. This measure was already in use for spotted gum [*Eucalyptus maculata*] and lemon-scented gum [*E. citriodora*]. The treatment was carried out on mature trees in December and April, when starch reserves were shown to be high. The starch content of the sapwood had fallen below the level necessary for an attack to develop in the sawn timber in six months in some of the trees, and in twelve months in all but two of them. In experiments with white cheesewood [*Alstonia scholaris*], sawn timber $\frac{3}{4}$ and $1\frac{1}{2}$ ins. thick retained concentrations of boric acid (0·14 per cent. or more) that were lethal to *L. brunneus* following immersion in solutions of 1·25 and 2·5 per cent. boric acid, respectively, for six hours at a temperature of approximately 200°F.

In the course of work in 1944–45 against the noxious weed, *Lantana camara*, numerous colonies of *Teleonemia scrupulosa*, Stål, were distributed in southern Queensland, where establishment has been less satisfactory than elsewhere [*cf.* **35** 220, etc.]. In the autumn, this Tingid was found at considerable distances from the liberation sites.

HAWKINS (J. H.). **Effect of calcic and magnesic Diluents of Calcium Arsenate on Bean Yields.**—*J. econ. Ent.* **39** no. 2 pp. 145–148, 5 figs., 7 refs. Menasha, Wis., 1946.

In preliminary tests in Maine during 1933 and 1934, dusts of calcium arsenate caused less injury to bean foliage when mixed with hydrated lime than when mixed with talc, diatomaceous earth, bentonite, sulphur, flour, or clay, and two forms of hydrated spray lime, with or without the addition of monohydrated copper sulphate (1 : 4), were therefore tested as carriers for calcium arsenate in subsequent years. One of them contained 72 per cent. calcium, expressed as calcium oxide, and less than 0·5 per cent. magnesium, expressed as magnesium oxide, and the other 46 per cent. calcium and 32 per cent. magnesium. The calcium arsenate was mixed with the carrier in the ratio of 1 : 7, 1 : 9 or 1 : 10, and the amounts applied and the number of applications were generally more than were required for effective control of the Mexican bean beetle [*Epilachna varivestis*, Muls.]. The effect on the plants was therefore evaluated mainly on the basis of yield. In 1937 and 1940–44, the calcium arsenate in the calcium lime caused a non-significant increase in yield in one year and decreases, which

were highly significant in two years, in the other five, the average decrease being 21·9 per cent.; the calcium arsenate in the magnesium lime caused increases, one highly significant, in four years and decreases, one significant, in three, with an average increase of 11·1 per cent. In the same years and 1939, calcium arsenate with calcium lime and the copper salt caused a highly significant increase in one year and decreases in the others, and calcium arsenate with magnesium lime and the copper salt a highly significant increase in the same year and small increases in all but one of the other years, the average increase being 19·2 per cent. In every year the magnesium-lime dust caused a higher yield than the calcium-lime dust, the average increase being 33 per cent. for calcium arsenate and lime and 17·6 per cent. for calcium arsenate, lime and copper sulphate. The addition of the copper salt to magnesium-lime dusts increased the average yield by 9·8 per cent.

The mixtures of magnesium lime, copper sulphate and calcium arsenate were least toxic to the bean plants and equalled or exceeded the other mixtures in control of *E. varivestis*. A dust of one part calcium arsenate and nine parts of the mixture of copper sulphate and magnesium lime did not damage the foliage and was more toxic to the beetle than a 1 : 10 dust. The decrease in yield due to insecticidal treatments was most noticeable in years of light infestation, the toxic effect on the plant being exceeded by the benefit from beetle control in years of heavy infestation.

TURNER (N.). **Diatomaceous Diluents for Dusts.**—*J. econ. Ent.* **39** no. 2 pp. 149–158, 7 figs., 25 refs. Menasha, Wis., 1946.

The following is based on the author's summary. Fifteen laboratory samples of diatomaceous earths were tested as diluents for pure ground derris root in the laboratory. Toxicity tests made with *Aphis rumicis*, L., on nasturtium leaves showed that one was superior to pyrophyllite, two others approached it and a fourth was somewhat less effective, but produced a steeper dosage-response curve. It was not possible to correlate the toxicity of the dusts with the physical data available, but materials of extremely fine particle size were not the most effective as diluents for the derris. In tenacity studies, curves flatter and steeper than that for standard Bancroft clay and parallel with it were produced; two of the materials of high tenacity were relatively effective as diluents for derris.

Materials selected on the basis of their toxicity and tenacity ratings were used in field tests in Connecticut. When used with cubé against the Mexican bean beetle [*Epilachna varivestis*, Muls.] on beans, their order of effectiveness was approximately the same as in the laboratory, but was correlated more closely with toxicity than with tenacity ratings. The more effective materials performed relatively better in comparison with pyrophyllite in the field than in the laboratory. With cryolite, materials of high tenacity performed well against *E. varivestis* on beans and against cabbage caterpillars, but less tenacious ones were also surprisingly good.

WOODSIDE (A. M.). **Cat-facing and Dimpling in Peaches.**—*J. econ. Ent.* **39** no. 2 pp. 158–161, 4 figs. Menasha, Wis., 1946.

Considerable loss of peaches occurs in Virginia through the types of injury known as cat-facing, in which bare, sunken areas that become rough and corky are developed, and dimpling, in which the sunken areas are pubescent. Both types are caused by insect feeding and tend to be distributed unevenly within and between the orchards and to be most severe at the edges and near fences, ditches and waste ground; they generally appear in the same orchards and parts of orchards each year. Bobb found that the tarnished plant bug [*Lygus oblineatus*, Say] caused cat-facing when caged on young peaches and that such

injury was common in orchards in which this Mirid had been abundant [*cf.* also *R.A.E.*, A **35** 176]; it is well known that the feeding of the plum curculio [*Conotrachelus nenuphar*, Hbst.] causes scars on peaches [**35** 84, etc.]; and severe dimpling resulting from heavy feeding by *Acrosternum hilare*, Say, was observed in part of an orchard in Amherst County in 1939.

Many fruits in two peach orchards in Rockingham County were scarred by the feeding of unknown insects in 1941, large numbers of *Euschistus servus*, Say, and a few of *E. tristigmus*, Say, were jarred from the trees in the following spring, and cat-facing was later common on the fruit. In 1943 and 1944, the Pentatomids were again numerous and cat-facing was frequent. In 1943, about 20 per cent. of the peaches in two orchards in Buckingham County were damaged by insect feeding in April–May; many examples of *E. tristigmus* and a few of *E. variolarius*, P. de B., were jarred from the trees about the middle of May, when both species were observed feeding on the fruit.

In the spring of 1944, overwintered Heteroptera entering peach orchards were jarred from the trees and caged separately on peach branches with undamaged fruit, which were examined every 3–4 days. The first bugs were caged on 18th April and the work was continued until harvest. Fruits attacked by species of *Euschistus* before sepal-fall dropped within 24 hours, and fruits less than $\frac{3}{8}$ in. in diameter when attacked dropped within three days; some fruits $\frac{3}{8}$–$\frac{1}{2}$ in. in diameter and many larger ones survived attack. *Thyanta custator*, F., *E. servus*, *E. tristigmus*, *E. variolarius* and *A. hilare* were observed to feed on peaches in the orchard, and all caused cat-facing on peaches on which they were caged. *Anasa tristis*, Deg., and *Chariesterus antennator*, F., caused cat-facing in the cages, but were not observed to feed on peaches in the orchard. Cat-facing developed when the fruits were attacked while small, and in Virginia appears to be caused chiefly by the three species of *Euschistus*. Adults of these Pentatomids caused dimpling on caged fruits of a diameter greater than 1 in. on which they fed during June and July, but they have generally left the trees before the fruits are large enough for this type of damage to develop. The nymphs fed readily on caged fruits and caused slight dimpling, but this injury was rarely found in the orchards. Small numbers of nymphs in the first and second instars were often jarred from the trees, but older ones were never found on them. Dimpling is characteristic of feeding by *Acrosternum hilare*, which seldom attacks peaches before July.

WOODSIDE (A. M.). **Life History Studies of *Euschistus servus* and *E. tristigmus*.** —*J. econ. Ent.* **39** no. 2 pp. 161–163. Menasha, Wis., 1946.

Overwintered females of *Euschistus servus*, Say, *E. tristigmus*, Say, and *E. variolarius*, P. de B., caged on peach trees in Virginia in 1944 [*cf.* preceding abstract] deposited eggs in clusters on the lower surfaces of the leaves. Eggs of *E. servus* were deposited from 10th May until after 15th June, and the nymphs remained on them without feeding until the first moult, after which they fed on foliage and fruit. Although they fed readily, they grew slowly, requiring more than two months to reach maturity, and the adults were smaller than those collected in the field, indicating that peach is not a satisfactory food for the nymphs. Females of the first generation deposited eggs, but all the nymphs from these died before mid-September. Eggs of *E. tristigmus* were deposited from 5th May to the end of June, hatching from 18th May. The nymphs were similar in behaviour to those of *E. servus*, but developed rather more quickly. The adults reared on peach were a little smaller than those collected in the field. A second generation was produced. Two caged females of *E. variolarius* deposited eggs; the resulting nymphs took longer to develop than those of the other two species, and no second generation was produced.

In 1945, *E. servus* and *E. tristigmus* were reared in the insectary, where they were given peach leaves and ripe tomatos as food. The overwintered females of

E. servus oviposited from 26th April to 18th July, and the egg and nymphal stages were completed in 5–25 and 41–63 days by the first generation and 6–12 and 48–66 days by the second. Only a few first-generation eggs of *E. tristigmus* were obtained, all between 18th April and 10th May. The egg and nymphal stages were completed in 14–20 and 43–62 days by the first generation and 7–9 and 48–57 days by the second.

Jarring of peach trees showed that *E. servus* and *E. tristigmus* are often fairly common in peach orchards in Virginia when the petals are falling and for several weeks afterwards ; most of them leave the peach trees by 1st June. Some eggs are deposited on peach trees by both species, but only first- and second-instar nymphs were found on them [*cf.* preceding abstract]. Very few of these Pentatomids were collected from weeds and cover crops in peach orchards or from crop plants in fields near infested orchards, except on common mullein (*Verbascum thapsus*), which bore considerable numbers of all stages of all three species. Nymphs of *E. servus* were found in small numbers on tomato and beans and nymphs and adults of *E. variolarius* in large numbers on maize.

GRAYSON (J. M.). **Life History and Habits of** *Strigoderma arboricola*.—*J. econ. Ent.* **39** no. 2 pp. 163–167, 2 graphs, 6 refs. Menasha, Wis., 1946.

The following is based on the author's summary. The results are given of investigations in 1944 and 1945 on the biology and economic importance of *Strigoderma arboricola*, F., in eastern Virginia, carried out in view of a report of serious injury to the pods of ground-nuts by larvae of this Rutelid in 1938–41 [*R.A.E.*, A **31** 403]. Examination of the pods of groundnuts at the time of digging revealed only minor injury that could have been caused by the larvae of this or any similar species. There was one generation in the year and the third-instar larvae overwintered in the soil at a depth of about 7½–8 ins. The egg stage and the first two larval instars lasted 8–19, 13–25 and 12–21 days in 1944 and 8–21, 12–30 and 10–36 days in 1945, the third instar 238–292 days in 1944–45, the pre-pupal stage 5–20 days in 1945, and the pupal stage 9–13 days in 1944 and 15–32 days in 1945. On an average, males and females lived 16·7 and 17 days, the preoviposition period was 12·5 days, and 26·3 eggs per female were deposited.

The adults were collected from the flowers of a number of different plants, and the grubs from the soil under all the principal agricultural crops grown in the groundnut-producing area of Virginia. The soil and air temperatures occurring during the principal periods of growth of *S. arboricola* are shown on graphs.

GAMBRELL (F. L.). **The European Chafer** *Amphimallon majalis* **and its Control in Lawns.**—*J. econ. Ent.* **39** no. 2 pp. 168–173, 2 figs., 9 refs. Menasha, Wis., 1946.

The following is based on the author's summary. *Amphimallon majalis*, Raz., was first observed in North America in 1940 [*cf. R.A.E.*, A **31** 21], and has become established over an area of approximately 150 square miles in western New York. In an area of about ten square miles, the larvae have caused serious damage in turf of lawns, golf courses, parks and cemeteries as well as in pasture grass and wheat fields. The life-cycle usually lasts one year [*cf.* **31** 301], but a small number of larvae go through two winters before transforming, possibly owing to lack of food, unusual temperatures or heavy soils.

Lead arsenate did not control the grubs when applied at 250 lb. per acre, but gave commercial protection of turf for 2–4 years (55·9–75·9 per cent. reduction in population) when applied at 500 lb. per acre and excellent protection for four years when applied at 1,000–1,500 lb. per acre [*cf.* **35** 200]. Calcium arsenate at 500 lb. per acre and a mixture of dusting sulphur and lead arsenate

at 1,000 and 75 lb., respectively, were comparable with lead arsenate at 500 lb. DDT gave promising control when applied to the turf as a suspension at the rate of 30 or 50 lb. per acre. In limited tests 30 lb. DDT per acre was as effective as 500 lb. lead arsenate per acre. DDT caused a much greater reduction of grubs within two months than 500 lb. lead arsenate did in the first year after application.

A suspension of 8 oz. DDT per 100 U.S. gals. water applied to trees killed adults that came to rest in them for several days after application but was less effective than the same material applied at a concentration of 5 lb. per 100 U.S. gals. Even at the higher concentration some gravid females deposited eggs before they died. The effect of such a spray in reducing the larval population has not been determined.

GINSBURG (J. M.). **Chemical Methods for Analysis of Dichloro-diphenyl-trichloroethane (DDT).**—*J. econ. Ent.* **39** no. 2 pp. 174–177, 19 refs. Menasha, Wis., 1946.

The author describes the principles of the various methods now being tested for the chemical analysis of DDT, based on reactions with either the aromatic (diphenyl) group, the aliphatic (chlorethane) group or the entire molecule, and gives references to the original publications in which details of procedure are set out. They comprise colorimetric, volumetric and gravimetric methods. Although they have been used with considerable accuracy for determining DDT in pure and technical grades, none of them is specific for this compound, chlor-organic compounds related to DDT being subject to the same reactions. Such chemicals may be encountered in spray mixtures as by-products in the manufacture of DDT, as ingredients present in insecticide and fungicide sprays, as impurities taken up with spray residues on fruits and from other sources. The methods discussed should be considered as temporary and used with caution, and discretion should be employed in evaluating results from DDT analysis of spray residues and commercial insecticide mixtures.

GOBLE (G. J.) & PATTON (R. L.). **The Mode of toxic Action of Dinitro Compounds on the Honeybee.**—*J. econ. Ent.* **39** no. 2 pp. 177–180, 4 figs., 9 refs. Menasha, Wis., 1946.

In view of the possibility of using dinitro sprays for thinning the blossom on some biennial-bearing varieties of apple in order to improve the quality of the fruit, investigations on their effect on bees were carried out in New York. From the results obtained it is concluded that the sodium salts of 3,5-dinitro-o-cresol [numbered with CH_3 as 1] and of 2,4-dinitro-o-cyclohexylphenol are very highly toxic to the honey bee ; that the dinitro compounds do not decompose, but remain potentially toxic for some time after application ; and that the flowers of some varieties are more attractive, and those of others less attractive, to bees after spraying. The median lethal dose of the sodium salt of the dinitro-cresol is 0·0021 mg. per bee, but doses as small as 0·00004 mg. have a measurable effect. The compounds take effect more rapidly at lower temperatures.

DRIGGERS (B. F.). **DDT on Peaches : Three Years Field Experiments.**—*J. econ. Ent.* **39** no. 2 pp. 181–183, 1 ref. Menasha, Wis., 1946.

Tests of DDT for the control of the oriental fruit moth [*Cydia molesta*, Busck] on peach in central New Jersey [*cf. R.A.E.*, A **32** 374] were continued in 1944 and 1945. All sprays contained 1 lb. actual DDT per 100 U.S. gals. and 1 U.S. quart 83 per cent. summer oil emulsion added to the diluted spray as an adhesive agent ; and all DDT mixtures, except the two commercial preparations used in 1945, were wetted with a solution of 2 oz. fish glue in 1 U.S.

pint water per lb. actual DDT before being put in the spray tank. In 1944, two plots were sprayed with DDT on 16th and 17th June, at the beginning of attack by the second generation, and one again on 14th July, at the beginning of attack by the third generation, which coincides with that by adults of the Japanese beetle [*Popillia japonica*, Newm.]. Technical DDT micronised with an equal amount of pyrophyllite was used. The proportion of injured fruit on unsprayed trees reached 20–30 per cent. The single spray reduced injuries on seven varieties of peach, ripening 3–6 weeks after the second application, but not enough to give commercial control, whereas the two sprays reduced it by about 90 per cent., which is considered satisfactory.

Since spraying against the second generation only did not give satisfactory control and might upset the work of the parasites that normally destroy the twig-feeding larvae of the second generation, sprays were tested only against the third generation of *C. molesta* and adults of *P. japonica* in 1945. A technical and a pure grade of DDT, each micronised with equal quantities of pyrophyllite or mixed with equal quantities of clay in a hammermill, and two commercial preparations containing DDT and conditioning agents were tested. All the DDT sprays were applied at a pressure of 400 lb. on 12th July, when eggs of the third generation of *C. molesta* were beginning to hatch and adults of *P. japonica* were beginning to enter the orchard, and the different preparations gave varying results, but the percentage of injured fruit on five varieties ripening 18–43 days after treatment was generally lower on sprayed than on unsprayed plots. The commercial preparations were the most effective, and they and the pure DDT with clay were the only ones consistently effective on all five varieties.

Each year, various Coleoptera, Diptera, Hymenoptera, Lepidoptera and Homoptera in the orchards were killed by DDT, but mites, particularly the European red mite [*Paratetranychus pilosus*, C. & F.], increased considerably on the peaches and on young apple trees interplanted with them. The mites caused heavy leaf-drop in 1943 and 1944, when July and August were dry, but not in 1945, when these months were wet. No spray injury to peach or apple was noted, and among the weeds in the orchards, only crab grass [*Digitaria sanguinalis*] was affected, and that only temporarily.

HUCKETT (H. C.). **DDT and other new Insecticides for Control of Cauliflower Worms on Long Island.**—*J. econ. Ent.* **39** no. 2 pp. 184–188, 6 refs. Menasha, Wis., 1946.

In tests on Long Island for the control of *Myzus persicae*, Sulz., and *Thrips tabaci*, Lind., on cauliflower in seed beds, seedlings that appeared on 26th June were sprayed or dusted three times between 3rd and 18th July with 2, 5 and 5·5 oz. dust or about 1 U.S. gal. spray per 100 ft. of row. The effect of the treatments was estimated by the growth of the plants, and only 8·4 per cent. of untreated plants were classed as large. The percentages of large plants were 39·5, 48·5 and 43·8 for dusts of 1 and 2 per cent. DDT in talc and of less than 1 per cent. DDT in an impregnated dust, 37·1 for a dust of cubé (5 per cent. rotenone), Celite [a commercially processed diatomaceous earth] and talc (1 : 1 : 8), and 26·9 for a dust of 2 per cent. DDD (dichlor-diphenyl-dichlorethane) in talc. They were 52·8 and 46·4 for emulsions of DDT in oil (0·025 and 0·0125 per cent. DDT), 43·2 for a suspension of finely ground technical DDT in a wettable powder (0·05 per cent. DDT), and 47·5 for a spray of cubé and skim-milk powder (0·025 per cent. rotenone), but the DDT suspension was less effective at lower concentrations.

In tests against *Pieris rapae*, L., *Plusia* (*Autographa*) *brassicae*, Ril., and *Plutella maculipennis*, Curt., on the autumn crop of cauliflower, treatments were applied three times between 8th August and 24th September to plants set out on 18th July at the rate of 26·5, 30·5 and 30 lb. dust per acre and 95,

171·5, and 180 U.S. gals. spray per acre. Dusts of 0·5–3 per cent. DDT in talc and an inert dust impregnated with less than 1 per cent. DDT were all highly effective and 2 per cent. DDD rather less so. Dusts containing pyrethrum, cubé, Ryanex [*cf. R.A.E.*, A **34** 137] or sabadilla were significantly less effective, largely owing to the shorter period for which they retained their effectiveness, though a dust of 20 per cent. sabadilla in exhausted pyrethrum gave promising results. DDT sprays were also very effective. Sprays containing 1·5 or 3 lb. wettable powder (25 per cent. DDT) per 100 U.S. gals. water (0·047 and 0·094 per cent. DDT) and 1 pint oil emulsion (25 per cent. DDT) in 100 gals. water (0·0312 per cent. DDT) were slightly more effective than sprays of lower DDT content, and the emulsions were more effective than the suspensions at the lower concentrations. Sprays of 4 and 6 lb. Ryanex per 100 U.S. gals. were relatively ineffective.

Bronson (T. E.), Smith (F. F.) & Simpson (G. W.). **Control of Aphids on Potatoes in northeastern Maine.**—*J. econ. Ent.* **39** no. 2 pp. 189–194, 4 refs. Menasha, Wis., 1946.

Experiments by T. E. Bronson in 1940–44 showed that sprays or dusts containing ground derris were the most effective materials for the control of Aphids on potato in north-eastern Maine, though they did not reduce the spread of leaf roll [*Corium solani* of Holmes] ; in 1944, DDT dusts gave promising results, and aerosols containing DDT were found by other workers to be highly toxic [*cf. R.A.E.*, A **34** 243]. Further tests were made in 1945 of various treatments with DDT, derris, nicotine and benzene hexachloride, applied with commercial or experimental equipment, to compare their effectiveness, when combined with fungicides against late blight [*Phytophthora infestans*] for the control of *Aphis rhamni*, Boy. (*abbreviata*, Patch), *Myzus persicae*, Sulz., *Macrosiphum solani*, Kalt. (*Myzus pseudosolani*, Theo.), *M. solanifolii*, Ashm., and other potato insects and to obtain information on their effect on the plants themselves, crop yields and the transmission of leaf roll.

In the first experiment, five applications were made between 6th July and 9th August, and counts made on 4th August showed that the percentage control of Aphids, as compared with untreated plants, was 99 for an aerosol released from a solution containing 5 per cent. each of DDT, cyclohexanone and a mixture of di- and tri-methylnaphthalenes, 35 per cent. acetone and 50 per cent. methyl chloride, and applied at a rate to give 1 lb. DDT per acre immediately after a fungicidal spray of tribasic copper sulphate ; 98 for a suspension of 2 lb. DDT per 100 U.S. gals. with tribasic copper sulphate, applied at a rate to give 2 lb. DDT per acre ; 98 for an emulsion containing 0·5 lb. DDT per 100 U.S. gals. dissolved in a mixture of di- and tri-methylnaphthalenes, a proprietary emulsifier and the fungicide, applied so as to give 0·5 lb. DDT per acre ; 86 for a dust of 5 per cent. DDT, tribasic copper sulphate and pyrophyllite, applied at a rate equivalent to 1·8 lb. DDT per acre ; and 80 for a spray of 3 lb. ground derris root (4 per cent. rotenone), a proprietary wetter and 1 U.S. pint soy-bean oil per 100 U.S. gals. The differences between the first three treatments were not significant, but all were significantly better than the other two. The plots were harvested early and there was not sufficient damage by Aphids to reduce the yield.

In the second experiment, in which the insecticides were combined with Bordeaux mixture, the suspension gave 27–70 per cent. Aphid control (12–18 per cent. increase in yield) when applied with a traction sprayer having two nozzles per row, and 70–80 per cent. control (1–39 per cent. increase) when applied with a tractor sprayer having three nozzles per row. Emulsions containing DDT in di- and tri-methylnaphthalenes, xylene and methylated naphthalene gave 87, 73 and 45 per cent. control (9, 24 and 14 per cent. increase in yield) when

applied with the traction sprayer, and an emulsion in di- and tri-methylnaphthalenes gave 73–97 per cent. control (16–20 per cent. increase) with the tractor sprayer. It was evident that tractor-mounted sprayers applying 100 U.S. gals. per acre reduced the Aphids more satisfactorily than did traction sprayers delivering 65–75 U.S. gals. per acre.

In the third experiment, the DDT dust with tribasic copper sulphate and a dust containing 5 per cent. benzene hexachloride, applied after Bordeaux mixture to give 1·8 lb. active ingredient per acre, afforded the most effective control of Aphids (99 and 97 per cent.). The DDT aerosol after Bordeaux mixture, the DDT emulsion (in di- and tri-methylnaphthalenes) with Bordeaux mixture, and a dust containing 7 per cent. zinc nicotinyl fluosilicate, applied with tribasic copper sulphate to give 0·8 lb. nicotine per acre, were also effective (90, 71–90 and 83 per cent.), but the emulsion gave only 50 per cent. control when applied as a concentrated spray with special equipment. When a four-nozzle sprayer equipped with vine-lifters was used, the kill of Aphids was slightly greater than that obtained with a standard three-nozzle sprayer. In general, the Aphid control was reflected in the yield. In the final experiments, applications of a DDT emulsion and a derris spray to potatoes on which *M. solani* was the dominant species showed that this Aphid is as susceptible to DDT as the others and that all of them are more susceptible to DDT than to derris.

There was no indication that the presence of DDT residue on the plants reduced the numbers of winged Aphids or prevented their establishment, and there was a higher proportion of infection with leaf roll in plants grown from tubers from treated plots than from controls. The treated plants remained green much later in the season than untreated ones, and all DDT treatments were highly effective against the Colorado potato beetle [*Leptinotarsa decemlineata*, Say] and flea-beetles [*Epitrix cucumeris*, Harr.], and none injured the plants or reduced the efficiency of the fungicides.

GLASGOW (H.). **DDT as a Control for the Pea Aphid.**—*J. econ. Ent.* **39** no. 2 pp. 195–199, 3 figs., 1 ref. Menasha, Wis., 1946.

The results are summarised of experiments against *Macrosiphum onobrychis*, Boy. (*pisi*, Kalt.) carried out in New York in 1945. Dusts of DDT in pyrophyllite were applied to lucerne on 25th May, when the ground and lower parts of the plants were damp and the temperature varied from 67 to 72°F. and the wind velocity from one to four miles per hour, with a motor duster equipped with a 60-foot trailer driven through the field at the rate of two miles per hour. The figures for percentage control, based on the averages of Aphid counts on 7th and 22nd June, were 70·6, 82·2 and 96·3, respectively, for dusts containing 1 per cent. DDT with no supplement or with 2 per cent. mineral oil or Velsicol 60 [a methylated naphthalene preparation], applied at 36–46 lb. per acre, 96·9 and 91·3 for those containing 3 per cent. DDT with 2 per cent. mineral oil or with 0·5 per cent. nicotine, applied at 42 and 48 lb. per acre, and 98·5 for one containing 5 per cent. DDT and 2 per cent. mineral oil, applied at 43 lb. per acre, as compared with 35·7–52 for dusts containing 0·25 per cent. rotenone, without a supplement or with 2 per cent. mineral oil, Lethane 60 [an aliphatic thiocyanate] or Velsicol 60, applied at 46–58 lb. per acre, 75·7 and 85 for those containing 0·5 or 1 per cent. rotenone with 2 per cent. mineral oil, applied at 60 and 47 lb. per acre, and 87 for one of 0·75 per cent. rotenone and 1·5 per cent. nicotine, applied at 48 lb. per acre. The mineral oil supplement appeared to add appreciably to the effectiveness of the DDT dusts, and when better solvents, such as xylene, Velsicol or benzene were used, the resulting increase in efficiency was much more pronounced.

In small-scale tests, sprays prepared by emulsifying a 50 per cent. benzene solution of DDT in a weak Bordeaux mixture or some other cheap emulsifying agent to give a concentration of 2 lb. DDT per 100 U.S. gals. and applied at the

rate of 150–200 U.S. gals. per acre gave satisfactory kills of the Aphid wherever adequate coverage was obtained, and in preliminary tests with concentrated sprays, a 15 per cent. solution of DDT in a light mineral oil, applied at 4–6 U.S. gals. per acre by means of standard oil burner nozzles delivering 1 U.S. gal. per hour gave relatively high mortality. Preliminary tests were also carried out on peas with a 5 per cent. solution of DDT in no. 1 fuel oil, applied on 18th and 19th June by means of the Todd Insecticide Fog Applicator [*cf. R.A.E.*, A **35** 259], which applies insecticides essentially in the form of a concentrated oil spray or aerosol. The fog was discharged at right angles to the direction of travel, and about 1·5 lb. DDT was applied per acre. In one field, the fog held in the peas and gave 99·3 per cent. mortality at 18 ft. from the machine, 93·1 at 50 ft., 84·1 at 100 ft., and 15·9 at 200 ft., but in most of the others air currents caused it to rise and drift above the peas for considerable distances and mortality was very erratic. Little was gained by treating the same plot twice, giving a dosage of about 3 lb. per acre, and the oil caused some injury to the plants.

DITMAN (L. P.), GOODHUE (L. D.), SMITH (F. F.) & BURKHARDT (G.). **Insecticidal Aerosols for Pea Aphid Control—Second Report.**—*J. econ. Ent.* **39** no. 2 pp. 199–204, 1 fig., 1 ref. Menasha, Wis., 1946.

In view of the results of small-plot tests [*R.A.E.*, A **34** 241–242], more extensive investigations were carried out in Maryland in 1945 to ascertain the effectiveness under varying weather conditions of aerosols applied to peas for the control of *Macrosiphum onobrychis*, Boy. (*pisi*, Kalt.) to determine the efficiency of dispensing apparatus similar to that used before, but mounted behind a jeep, to obtain information on the effect of different speeds of operation and to improve aerosol solutions and reduce their cost. All formulae for solutions are given as per cent. by weight, and application of a 5 per cent. DDT solution at speeds of 3, 5, 6, 7, 10 and 15 miles per hour gave dosages of 0·8, 0·5, 0·4, 0·36, 0·25 and 0·15 lb. DDT per acre, respectively. A solution of 5 per cent. each of DDT, aromatic petroleum solvent, and cyclohexanone, 35 per cent. acetone and 50 per cent. methyl chloride, released at a speed of 5 m.p.h. on 27th April, when there was a drizzling rain, a wind velocity of nearly 20 m.p.h. and a temperature of 55°F., reduced the Aphid population by 94·4 per cent., as compared with the controls, and the same solution applied on 9th May at 5, 10 and 15 m.p.h. reduced it by 88·5, 87 and 84·1 per cent. In a test on 28th April, when the temperature was 53–59°F. and the wind velocity nearly 12 m.p.h., a solution of 5 per cent. each of DDT, cyclohexanone and lubricating oil, 35 per cent. acetone and 50 per cent. methyl chloride, applied at 3, 5 and 6 m.p.h. reduced infestation by 98·8, 97·3 and 97·7 per cent. ten days after treatment, and increased the yield of shelled peas by 41·1, 10·7 and 67·4 per cent., one of 5 per cent. each of DDT and cyclohexanone, 10 per cent. aromatic petroleum solvent, 30 per cent. acetone and 50 per cent. methyl chloride, applied at 3 m.p.h., reduced infestation by 99 per cent. and increased yield by 57·5 per cent., and one of 5 per cent. each of DDT, aromatic petroleum solvent, and cyclohexanone, 25 per cent. acetone and 60 per cent. methyl chloride, applied at 3, 5 and 7 m.p.h., reduced infestation by 99·6, 99·2 and 96·9 per cent. and increased yield by 50·4, 43·3 and 40·5 per cent. Treated plants remained green longer and gave yields of better quality than untreated ones.

Nine aerosols from solutions of 5 per cent. DDT in various solvents, applied at 5 m.p.h. on 9th May, in clear weather with a temperature of 59–65°F. and a wind velocity of 11·4 m.p.h., reduced Aphid infestation by about 82–88 per cent. ten days after treatment, whereas one from a solution of 2 per cent. rotenone, 5 per cent. each of aromatic petroleum solvent and cyclohexanone, 35 per cent. acetone and 53 per cent. methyl chloride, applied at the same rate on the same day, reduced it by only 45·4 per cent. There was some reduction

in population in the untreated plots two days after treatment, apparently owing to drift of the aerosols, but there was a considerable increase during the following eight days, indicating a lack of residual toxic action, whereas there was very little increase on the DDT plots and only a moderate one on the rotenone plots during this period. The yield of peas at harvest was greater in all DDT plots than in untreated ones, but there were considerable differences between treatments, which were not correlated with Aphid control or with foliage injury, and it is concluded that although certain solvents caused obvious foliage injury, the plants outgrew any deleterious effects. An aerosol from a solution containing 5 per cent. DDT, applied on 16th May, which was earlier than was considered desirable, at a temperature of 82°F. and a wind velocity of 18 m.p.h., gave 98·1, 98·3, 95·9 and 81·8 per cent. reduction in population on 31st May when applied at 3, 5, 10 and 15 m.p.h., and two others applied at 5 m.p.h. on 22nd May, when growth of plants and Aphid populations had reached the stage at which treatment was desirable, at a temperature of 84°F. and wind velocity of 18 m.p.h., gave more than 98 per cent. control. Since the reduction of Aphids by treatment on the two dates was similar, it is concluded that there is a considerable period during which peas may be treated. Treated plants remained green and succulent for a week longer than untreated ones.

No consistent differences in effectiveness were obtained whether the aerosol was released from 24 oil-burner nozzles, each giving 2 U.S. gals. per hour, or 16 each giving 3 U.S. gals. per hour, indicating that the larger nozzles can be used satisfactorily. The most serious mechanical problem was nozzle stoppage, caused by fine particles of dirt in the aerosol solutions, crystallisation of insecticide in the nozzles, and formation of insoluble precipitates due to corrosion of the containers or pipes by acids in the solutions. The first was corrected by the use of a filter, and the second by replacing the lubricating oil in aerosol solutions by a non-volatile aromatic petroleum oil of high solvent power. The third was much reduced by adding 1 per cent. propylene oxide, which was sufficient to combine with the acids in the aerosol solutions or those produced when they were allowed to stand, provided that good materials were used ; it is advisable to use only refined methyl chloride, and even this will require propylene oxide as a stabiliser. The use of larger nozzles may reduce the chances of clogging.

It is concluded that DDT aerosols were effective under varying conditions, that 0·5 lb. or more DDT per acre applied at speeds of 3–5 miles per hour gave better results than smaller quantities applied at higher speeds, and that treatments were generally more effective on Alaska peas than on wrinkled varieties. The slower maturation of treated peas tends to increase yields and to permit harvesting to be delayed until the quality is high.

Gyrisko (G. G.), Wene (G. P.) & Rawlins (W. A.). **DDT to control Potato Aphids.**—*J. econ. Ent.* **39** no. 2 pp. 205–208, 3 refs. Menasha, Wis., 1946.

In field experiments carried out in 1945 on Long Island and in Western New York, where *Macrosiphum solanifolii*, Ashm., and *Myzus persicae*, Sulz., are important pests of potato, dusts and sprays of DDT were more effective against the former than dusts or sprays of other aphicides but less so than nicotine fumigation. The surviving Aphids reproduced more rapidly during the week following treatment with DDT than after the other insecticides. DDT sprays were more effective against *Myzus persicae* than against *Macrosiphum solanifolii* and kept the populations at a low level for 8–18 days after treatment. This difference in control of the two species may be due to the fact that *Macrosiphum* is found chiefly on the rapidly growing terminals, whereas *Myzus* lives on the lower parts of the plant and is more likely to come in contact with DDT deposits.

In comparisons of 0·75–5 per cent. dusts against *Macrosiphum*, suspensions of 0·25–2 lb. DDT per 100 U.S. gals. against both species and emulsions of

0·5–2 pints 20 per cent. DDT solution per 100 gals. against *Myzus*, Aphid control and (in the case of dusts and suspensions) tuber yields increased with each increment of DDT, and the results indicate that at least 2 lb. DDT per acre, as spray powder or dust, is needed for each application during the period of Aphid infestation and that frequent applications are required to keep populations at a reasonably low level, particularly in the case of *Macrosiphum solanifolii*.

HARMAN (S. W.). **DDT for Codling Moth Control in western New York in 1945.**— *J. econ. Ent.* **39** no. 2 pp. 208–210, 1 ref. Menasha, Wis., 1946.

Tests of DDT against the codling moth [*Cydia pomonella*, L.] on apple in western New York [*R.A.E.*, A **34** 248] were continued in 1945. Three cover sprays were applied against the first generation on 26th June and 9th and 16th July and one against the second on 13th August. Spray quantities are given per 100 U.S. gals. The numbers of entries and (in brackets) superficial injuries by the larvae per 100 apples were reduced from 85·5 (42·4) on unsprayed trees to 0·7 (2·6), 0·5 (2·4) and 0·5 (2·6), respectively, by sprays containing $2\frac{1}{2}$ and $3\frac{3}{4}$ lb. Gesarol AK 40 (40 per cent. DDT) and $1\frac{1}{4}$ lb. of this material with 2 lb. lead arsenate, 1 (2·7) and 0·4 (2) by sprays of 3 and 6 lb. DDT concentrate (17 per cent. DDT), 0·8 (2·7) by a spray of 3 lb. of a blend of Black Leaf Dry Concentrate and DDT (7 per cent. nicotine and 17 per cent. DDT), 0·9 (3·8) by one of 4 lb. Deenate 25W (25 per cent. DDT), and 2·4 (25·8) by one of 3 lb. lead arsenate and 2 lb. hydrated lime. Sprays containing 1 lb. actual DDT per 100 U.S. gals. water thus gave practically the same control in whatever form the DDT was used. The combined spray of DDT and lead arsenate may be of value if lead arsenate is desirable in the summer apple spray programme for the control of curculio [*Conotrachelus nenuphar*, Hbst.] and apple maggot [*Rhagoletis pomonella*, Walsh].

Determination of the residues left on the apples at harvest indicated that there should be little difficulty in keeping within the tentative legal tolerance of 0·05 grain DDT per lb. fruit [*cf.* **35** 110], but the lead and arsenic deposits were more than twice the legal tolerances of 0·05 and 0·025 grain.

In an orchard in which ten cover sprays of lead arsenate at double strength, supplemented with nicotine and with the addition of summer oil in all but the first three, did not prevent 30 per cent. serious injury in 1944, five cover sprays of 1 lb. DDT per 100 U.S. gals. resulted in 99 per cent. uninjured fruit in 1945, though there was no sound fruit on unsprayed trees. Similar results were obtained from the same treatment on pears. No spray injury developed on the trees. The apple trees treated with DDT were noticeably free from *Paratetranychus pilosus*, C. & F., during the spraying season, when adjoining unsprayed ones showed 100–200 mites per leaf; the latter suffered more than 50 per cent. leaf drop by harvest. The mites did not increase on the DDT plots until after the spraying season, and this was so late that no noticeable damage developed, except for some bronzing of foliage on the Baldwin variety, though the heaviest deposition of mite eggs was found at harvest on Baldwin apples that had been sprayed with DDT.

In preliminary tests, promising results were given by sprays containing 1 lb. DDT per 100 U.S. gals., made by dissolving technical-grade DDT in benzene at the rate of 1 lb. per U.S. quart and emulsifying the solution in the spray tank. They did not injure potatoes, peas or apple foliage, and the residue on apple foliage remained toxic to flies (*Pollenia rudis*, F.) for noticeably longer than that from the standard suspensions of DDT. When sprayed and unsprayed apples were exposed to attack by larvae of *Cydia* (*Grapholitha*) *molesta*, Busck, only 3 per cent. of the larvae entered the sprayed fruits as compared with 100 per cent. for unsprayed ones. The advantages of this spray over a suspension appear to be that the residue remains toxic to insects for a longer period, the

kill seems to be quicker and more complete, there is no visible residue except that left by the emulsifying agent, and the spray is easily prepared at approximately one-third of the current cost of the dry concentrates.

WHEELER (E. H.) & LA PLANTE jr. (A. A.). **DDT and Ryanex to control Oriental Fruit Moth : their Effect upon Parasite Populations.**—*J. econ. Ent.* **39** no. 2 pp. 211–215, 2 figs., 3 refs. Menasha, Wis., 1946.

Since parasites, principally the introduced Braconid, *Macrocentrus ancylivorus*, Rohw., give commercial control of *Cydia* (*Grapholitha*) *molesta*, Busck, on peach in New York in most seasons, but not all, and since DDT did not entirely suppress twig-infesting larvae in preliminary tests on peach in 1944 and is known to be toxic to *Macrocentrus* [*R.A.E.*, A **33** 213], investigations were carried out in 1945 to determine the effect of this insecticide on populations of the moth and its parasites throughout the season when a full schedule was applied to large blocks of trees. DDT, in the form of a 25 per cent. water dispersible powder used at concentrations giving 1 lb. actual DDT per 100 U.S. gals., and Ryanex [*cf.* **34** 137], at 6 lb. per 100 U.S. gals. with a wetting and spreading agent, were applied on 18th June, 12th July and 3rd and 23rd August and the fruit was harvested on 20th and 21st September. The test blocks were squares of equal size, each containing about 100 trees. To insure the presence of parasites, 50 females of *M. ancylivorus* were liberated in the middle of each block on 22nd and 27th June, 200 on 14th July and 100 on 8th August. Collections of injured twigs, from which insects were reared, made every week from ten trees receiving each treatment (including release of parasites only) showed that DDT and Ryanex reduced the numbers of twig-infesting larvae of *C. molesta* per tree from 7·7 to 2·4 and 3·2, respectively, in the first generation and from 86·5 to 18·9 and 29·7 in the second and the percentage parasitism from 48·1 to 8·3 and 12·5 for the first generation and from 51·8 to 32·8 and 39·4 for the second. For a short period after each application, Ryanex seemed equal to DDT in effectiveness, but its residual action was inferior. It seems probable that two or more applications of DDT at intervals of 2–3 weeks throughout a peach orchard would practically exterminate the parasites normally found attacking *C. molesta* in New York ; Ryanex would have a similar effect when used at intervals short enough to provide effective moth control.

Examination of the fruit for visible and internal injury, 28 days after the last application, showed that DDT provided almost complete protection until the week before harvest (89·8 per cent. control), but that Ryanex was less effective (44·2 per cent.). No spray injury to foliage or fruit was observed, but infestation by *Tetranychus telarius*, L., occurred late in the season on trees sprayed with DDT.

DITMAN (L. P.). **DDT Preparations for Control of the Pea Aphid.**—*J. econ. Ent.* **39** no. 2 pp. 219–222. Menasha, Wis., 1946.

The following is substantially the author's summary of this account of investigations carried out in Maryland in 1945. In the experimental and commercial applications described, dry-mixed DDT dust and suspensions of DDT in water did not give satisfactory control of the pea Aphid [*Macrosiphum onobrychis*, Boy.] on peas. All the emulsions of solutions of DDT tested gave excellent kills, but some caused serious injury to the plants, which was attributed to the direct action of the solvent or the emulsifier and to excessive amounts of one or other of these ingredients. Emulsions of DDT in xylene, ethylene dichloride and aliphatic petroleum oils, in which minimum amounts of solvent and emulsifier were used, appeared to be the safest of the treatments used on pea foliage. In limited phytotoxicity tests, Velsicol AR-60 [an isomeric mixture of alkyl-substituted naphthalenes] appeared to be a satisfactory solvent.

Triton X-100 [aralkyl polyether alcohol] was the most satisfactory emulsifier tested. Apparently a safe formula for spraying consists of 390 cc. xylene or ethylene dichloride, 227 gm. DDT and 20 cc. Triton X-100 per acre of peas, diluted with enough water to make the amount of spray to be applied. About 0·5 lb. DDT per acre, applied in a water emulsion, appears to be ample for control of the Aphid, and this spray was superior to a proprietary rotenone emulsion used at twice its recommended concentration and to the standard spray of 3 lb. ground derris root (6·3 per cent. rotenone) with 4 oz. sodium lauryl sulphate per 100 gals.

GOODHUE (L. D.) & RILEY (R. L.). **Particle-size Distribution in liquefied-gas Aerosols.**—*J. econ. Ent.* **39** no. 2 pp. 223–226, 6 figs., 4 refs. Menasha, Wis., 1946.

A detailed description is given of a method of measuring the particle size of aerosols propelled with liquefied gas by collecting the particles on oleophobic slides and projecting their image on a calibrated cross-hatched screen. The particle size of an aerosol was found to increase as the concentration of non-volatile material in the liquefied gas increased. Studies with four types of nozzle showed that the type affects the particle size, nozzles allowing some drop in pressure and partial ebullition before the liquid is expelled being the most efficient. The particle-size distribution curves for some aerosols of different composition are given.

GLASGOW (R. D.) & COLLINS (D. L.). **The thermal Aerosol Fog Generator for large scale Application of DDT and other Insecticides.**—*J. econ. Ent.* **39** no. 2 pp. 227–235, 24 figs., 3 refs. Menasha, Wis., 1946.

Thermal aerosol fog generators show great promise for the application of insecticides on a scale hitherto often impracticable. The apparatus used to disperse heated oil in air as microscopic droplets to form a fog screen proved unsuitable for dispersing DDT and other oil-soluble insecticides, since the particles rise too high, drift far and settle slowly and the high temperature used to produce the fog would decompose much of the dissolved insecticides. Modified generators were therefore developed. Of the two machines of which the mode of operation is here described and which were tested in New York in 1945, the Hochberg-LaMer thermal aerosol insecticide fog generator is of the " wet " type. It was used with water and an oil solution of DDT and depends on superheated steam under controlled temperature and pressure to break up the oil solution into droplets of the desired size. The Todd thermal aerosol insecticide fog generator, also known as the TIFA (Todd Insecticide Fog Applicator), produces the fog by spraying an oil solution of DDT into a mixing chamber where the droplets are picked up and heated to the desired degree in a blast of hot air maintained at a controllable temperature and pressure, and thus dispersed into smaller droplets when discharged at atmospheric pressure. Both generators can also disperse emulsions and suspensions and have been adapted for operation from the air. They were both used against noxious Diptera [*cf. R.A.E.*, B **35** 128], and the TIFA to control clothes moths in a wool warehouse [*cf.* next abstract]; it is also stated that the Hochberg-LaMer generator was successfully used against canker worms in a wooded area ten acres in extent.

However applied, the effectiveness of an aerosol fog depends on particle size. The influence of particle size on dispersal by wind and on distribution of the toxic ingredient, which also affects hazard to non-injurious organisms, is discussed. It is thought that the best results out-of-doors may be expected with droplets measuring 10–50 microns in diameter. Coarse particles are needed

for the control of forest and orchard pests from the air to give the droplets sufficient weight and rate of fall. Indoors, much smaller particles seem desirable.

COLLINS (D. L.) & GLASGOW (R. D.). **DDT thermal Aerosol Fogs to control Clothes Moths in a Wool Storage Warehouse.**—*J. econ. Ent.* **39** no. 2 pp. 241–245, 2 figs. Menasha, Wis., 1946.

An account is given of an experiment in October 1945 in which a DDT fog generated by a Todd Insecticide Fog Applicator [see preceding abstract] was tested for the control of clothes moths (largely *Tineola biselliella*, Humm.) in a heavily infested five-storey wool warehouse in New York State. The floors measured about 100 × 160 ft. and the lowest storey was 15 ft. high and the rest 10 ft. The apparatus was mounted on a hand truck, used to release the fog from a point near the middle of one side of each floor, and moved from floor to floor by means of the lift. Treatment of each storey was effected in about 15 minutes, using about 1 lb. DDT. To prevent the risk of fire or explosion, water emulsions of the oil solutions were used, or carbon tetrachloride was added. A mixture of a high boiling aromatic petroleum hydrocarbon and carbon tetrachloride (1 : 3), containing 10 per cent. DDT, was used on the ground and fourth floors, the same with the addition of about 0·5 per cent. pyrethrins on the third, an emulsion consisting of one part of an emulsible concentrate containing 25 per cent. DDT and one part water on the second, and a mixture of equal parts of carbon tetrachloride and a high boiling, paraffin series, petroleum hydrocarbon, containing 8 per cent. DDT, on the first. The fogs released on the first and second floors were irritating to the eyes, nose and throat and the others relatively non-irritating.

Treatment was applied on 16th October, when the temperature was 60°F., and all doors closed. On the following day, large numbers of dead moths were found on all floors, and a few living ones showing signs of DDT poisoning near doors or windows where there had been some air leakage ; examples of the latter placed in cages were dead a day later. Moths that had been caged in different parts of the warehouse on the day before treatment were all dead or severely affected 24 hours after it, indicating that all the treatments tested were completely effective against the adults. Full-grown and nearly full-grown larvae in cages were not visibly affected on the first day after treatment, but most of them were dead a day later. Several newly emerged moths were observed on 18th October, and 14 of them were caged ; by the following day, ten were dead and four were still active. On 30th October, a few recently dead and a few moribund larvae were observed on the floor near bags and bales of wool. These had apparently encountered lethal quantities of DDT residues on emerging from within the wool to spin their cocoons on the outer surface of the burlap. Traps kept in operation for 11 days before treatment, when the temperature ranged from 58–63·5°F., and 11 days after it (58–62·5°F.) caught 4,300 and two moths, respectively, on the fourth floor, 450 and one on the third, and 839 and none on the others.

LANGFORD (G. S.) & CORY (E. N.). **Japanese Beetle Attractants with special Reference to Caproic Acid and Phenyl Ethyl Butyrate.**—*J. econ. Ent.* **39** no. 2 pp. 245–247, 3 refs. Menasha, Wis., 1946.

Further field investigations on attractants for use in traps for the Japanese beetle [*Popillia japonica*, Newm.], carried out in Maryland in the summer of 1945 [*cf. R.A.E.*, A **35** 119, etc.], resulted in the discovery of mixtures that could entirely replace geraniol and eugenol or be mixed with them to make a bait much more attractive than the standard formula of geraniol and eugenol

(9 : 1). Of 100 mixtures selected, ten that were 2–3 times as effective as the standard, 16 that were 1–2 times as effective, and 14 that were somewhat less effective are shown in a table.

Phenyl ethyl butyrate and caproic acid were exceedingly promising as ingredients for baits and made baits that compared favourably with the standard when used together or in combination with anethol and valeric acid or phenyl iso valerate. A combination of phenyl ethyl butyrate and caproic acid (2 : 8) was rather more effective than the standard. Caproic acid appeared to improve many bait mixtures ; when used as a partial replacement and in combination with anethol, eugenol or geraniol it increased attractiveness considerably. Phenyl ethyl butyrate also improved the efficiency of combinations of geraniol and eugenol or of combinations in which these materials were partially replaced by either anethol or caproic acid. A mixture of caproic acid, phenylethyl butyrate and eugenol (8 : 1 : 1) was one of the most efficient and practical combinations tested ; it attracted nearly three times as many beetles as the standard and can be recommended for field use. Ethyl caproate, phenyl iso butyrate, phenyl iso valerate and iso valeric acid in various combinations with caproic acid, eugenol, geraniol and phenyl ethyl butyrate formed outstanding and attractive baits, which, however, were more complicated and expensive ; a mixture of phenyl iso valerate, eugenol and geraniol (8 : 1 : 1) attracted about 3·8 times as many beetles as the standard.

The chemicals tested were more volatile than geraniol and eugenol, and the more efficient mixtures containing high percentages of them may evaporate 2–3 times as fast as the standard bait. This is possibly a reason for their greater effectiveness, but the chemicals in the mixture and the ratio in which they are combined are also important.

Adams (J. A.) & Wheeler (E. H.). **Rate of Development of Milky Disease in Japanese Beetle Populations.**—*J. econ. Ent.* **39** no. 2 pp. 248–254, 9 refs. Menasha, Wis., 1946.

The following is substantially the authors' summary. Under climatic conditions at Poughkeepsie, New York, the currently used light dosages of standard milky-disease dust containing spores of *Bacillus popilliae*, applied to selected points in the soil to control *Popillia japonica*, Newm., are slow in action. Higher dosages of dust, at rates of 10, 100, 500, 1,000 and 2,000 lb. per acre, were suspended in water and broadcast in April 1944 on small infested field plots, and the results were observed by means of frequent soil diggings. Small percentages of diseased larvae were found in all the plots within 1–6 months after treatment, but a satisfactory degree of control was achieved only at the highest dosage after 18 months. The data indicate that, in southern New York, raising the dosage of spore dust from 2 to 2,000 lb. per acre can reduce the time required to bring about satisfactory control from about four years to about two. The results support the current practice of using standard spore dust at inoculative dosages wherever eventual and permanent reduction of populations of *P. japonica* is sought and do not support the use of very heavy applications as substitutes for chemical soil treatment on restricted areas in which immediate control may be imperative.

Watkins (T. C.). **An Evaluation of various Sprays to control immature Squash Bugs.**—*J. econ. Ent.* **39** no. 2 pp. 255–261, 11 refs. Menasha, Wis., 1946.

Various insecticides and combinations of insecticides were tested in the laboratory as sprays against the eggs, newly hatched nymphs, nymphs 21 days

old or more, and adults of *Anasa tristis*, Deg. Most of the results were negative, indicating that this Coreid possesses a marked degree of resistance to some of the commonest insecticides. Of 26 sprays tested against the eggs, none gave satisfactory kills, with the possible exception of a proprietary preparation containing 20 per cent. of a dinitrocyclohexylamine salt of dinitro-ortho-cyclohexylphenol; the only other spray that gave more than 50 per cent. mortality was a light petroleum oil at concentrations known to be injurious to foliage. Twelve of 21 sprays tested against newly hatched nymphs gave more than 90 per cent. mortality, but most of them had to be used at concentrations so high as to be uneconomic for the protection of squash in New York. Marked toxicity was shown by materials containing pyrethrum and by rotenone sprays at high concentrations. Ten of these materials that were tested against the older nymphs failed to give satisfactory control or did so only at uneconomic concentrations, and the only one (a pyrethrum extract) that was tested against the adults was also uneconomic. Of the three DDT sprays tested, an emulsion of a solution of 5 per cent. DDT in oil was effective against young nymphs, whereas two suspensions were not; the effectiveness of the emulsion was not due to toxicity of the oil base, as oil alone gave poor mortality unless used at much higher concentrations, but it is possible that the oil permitted better penetration of the DDT through the integument. In field experiments this spray caused some injury to both tomato and squash. It is suggested that for further laboratory or field testing of DDT, an emulsible oil containing a higher percentage of DDT should be used in order to apply a large enough dosage to kill older nymphs while reducing the amount of oil applied to a concentration not injurious to foliage. Two copper fungicides included in the tests showed no appreciable toxicity to either eggs or active stages.

GYRISKO (G. G.). **Some new Insecticides for Potato Insect Control.**—*J. econ. Ent.* **39** no. 2 pp. 262–263, 1 ref. Menasha, Wis., 1946.

In tests of various dusts against *Empoasca fabae*, Harr., and adults of *Epitrix cucumeris*, Harr., on potato in New York in 1945, DDD (dichlor-diphenyl-dichlorethane), DDT and a residue from the refinement of DDT were compared at various concentrations and with other insecticides. The crude residue contained about 16 per cent. p,p′DDT in a mixture of other isomers, mostly o,p′DDT, and as it was semi-liquid, it was used with 50 per cent. of a proprietary mixture of alkylated naphthalenes and anthracenes to impregnate a carrier. In the first of three tests, the percentages of control of *Epitrix* and (in brackets) of *Empoasca* after 48 hours were 99·6 (99·3) and 99·2 (99·5) for 5 and 2·5 per cent. DDT mixed with sulphur, 96·7 (97·9) for 2·5 per cent. DDT fused with sulphur, 96·1 (99·1) for 2 per cent. DDT residue in pyrophyllite, 95·9 (99·5) for 2 per cent. DDT in pyrophyllite, 84 (85·3) for 25 per cent. P.C.H. (a preparation containing piperonyl cyclohexanone added to pyrethrum marc), 0 (70·6) for 2 per cent. Lethane B–71 (β,β′dithiocyanodiethyl ether), 91·2 (83·6) for 2 per cent. unmicronised DDD in pyrophyllite, and 92·1 (82·2) for a dust containing 0·75 per cent. rotenone, 30 per cent. sulphur and 0·075 per cent. pyrethrins. In a second test, the percentages were 90·3 (76·1), for 25 per cent. P.C.H., 99·4 (96·5), for both 1 and 2 per cent. micronised DDD, 98·1 (93·9) and 98·3 (96·1) for 1 and 2 per cent. DDT residue, 99·5 (97·6) and 99·5 (95·1) for 1 and 2 per cent. DDT in pyrophyllite, and 99·1 (95·1) for 1 per cent. DDT fused with sulphur. In the third they were 98·8 (99) and 99·8 (99·3) for 3 and 5 per cent. DDT in pyrophyllite, 99·8 (99·2) for 5 per cent. DDT mixed with sulphur, and 99·8 (98·8) and 100 (98·8) for 3 and 5 per cent. micronised DDD in pyrophyllite. The control given by DDT and related compounds was maintained for 4–8 days and they were about equally satisfactory, but the other materials had little residual effect.

PYENSON (L.). **Eradication of Boxwood Leafminer and the Boxwood Psyllid.**—*J. econ. Ent.* **39** no. 2 p. 264, 2 refs. Menasha, Wis., 1946.

In the course of operations against tent caterpillars [*Malacosoma*] on Long Island, two box trees [*Buxus*] heavily infested with *Monarthropalpus buxi*, Lab., were thoroughly sprayed from the inside and outside with wettable DDT powder in water (2 lb. actual DDT per 100 U.S. gals.) with a proprietary spreader-adhesive, on 16th April, 1945. Adults began to emerge on 7th May and continued for three weeks, but none was seen flying round the bushes and hundreds were dead or dying on the ground. The residue was still effective at the end of emergence, although a little over seven inches of rain fell. In another experiment, a miscible summer oil solution of 20 per cent. DDT diluted with water (1 : 100) and applied a few days before emergence left no visible residue, but gave complete control during the three weeks of emergence ; where it was used at 1 : 400, however, a few adults were seen flying about the trees after two weeks. No injury to the trees was observed, but *Paratetranychus yothersi*, McG., tended to increase to injurious numbers on them.

Spraying with nicotine sulphate and soap [*cf. R.A.E.*, A **32** 403] was not effective against *Psylla* (*Psyllia*) *buxi*, L., once the nymphs were sheltered in the new growth, but a spray of nicotine sulphate with NNO [mannitan monolaurate] in water (4 : 1 : 1,600) applied on 20th June, 1941, two weeks after adults were first noticed, first to the outside and then to the inside of the bushes, gave excellent kill, and the treated bushes were free from new injury the next year. Subsequent annual applications have shown that complete eradication in a given area can be achieved by this change in timing. As the preoviposition period lasts at least six weeks, timing of the spray need not be very accurate. All shrubs surrounding the box trees should be sprayed at the same time. DDT applied against *M. buxi* did not appear to have any residual effect on the Psyllid.

HERVEY (G. E. R.). **Effect of various Dust Mixtures on Incidence of the Cabbage Aphid.**—*J. econ. Ent.* **39** no. 2 p. 265, 7 refs. Menasha, Wis., 1946.

During experiments with various dust mixtures for the control of caterpillars on cabbage in New York in 1945, infestation by *Brevicoryne brassicae*, L., increased considerably on some of the treated plots. The dusts were applied three times at intervals of about 2½ weeks in August and September, and counts of plants infested by the Aphid on 24th September, when infestation was at its peak, showed that the percentage of plants infested increased from 20·4 for no treatment to 95·3 for 25 per cent. cryolite, 85 for 25 per cent. cryolite with 1 per cent. mineral oil, 88·1 for 25 per cent. micronised cryolite, 86·2 for 25 per cent. lead arsenate, 42·2 for 2 per cent. DDT, 30, 34·5 and 44·5 for 1 per cent. DDT alone, with 2 per cent. Velsicol and with 2 per cent. oil and 34·3 for 0·5 per cent. rotenone. The plants of which more than 80 per cent. were infested, sustained considerable commercial damage, but the others did not. The only treatment that appeared to affect the Aphids adversely was a 3 per cent. dust of benzene hexachloride (8 per cent. γ isomer), which reduced the percentage of plants infested to 1·1.

HOUGH (W. S.). **The Control of Mites on Apple Trees sprayed with DDT.**—*J. econ. Ent.* **39** no. 2 pp. 266–267. Menasha, Wis., 1946.

Since heavy mite populations developed on apple trees that received two or more sprays of DDT in Virginia in 1944 (878–5,379 per 100 leaves in one orchard and 120–1,477 in another, as compared with 2–7 on trees that received the regular arsenical sprays throughout the season), and the foliage was

bronzed on most of the trees that were sprayed with concentrations of 6·4–24 oz. DDT per 100 U.S. gals. water, attempts were made to suppress or prevent the development of mites in some of the plots sprayed with DDT in 1945. The species present were *Paratetranychus pilosus*, C. & F., and *Tetranychus schoenei*, McG., the latter being the more numerous in 1944 and the former in 1945. The DDT schedules applied against the codling moth [*Cydia pomonella*, L.] in 1945 began on 30th April with the first cover spray, or on 15th May with the second, and finished on 7th or 17th August, with the seventh or eighth. The population density of mites did not alter with the concentration of DDT used in the experiments (4–16 oz. per 100 U.S. gals.).

DDT alone, with lead arsenate or with summer oil emulsion resulted in populations of approximately 1,000–3,000 mites per 100 leaves. The respective populations were only 19 and 73 for DDT in sprays 1–8 with the addition of 0·67 lb. 40 per cent. dinitro-o-cyclohexylphenol per 100 U.S. gals. spray in sprays 5, 7 and 8 and in sprays 5, 6, 7 and 8, 134 for 2 lb. of a mixture of DDT and xanthone in sprays 3–8, 641 and 708 for DDT in sprays 1–8 or 2–7 with the addition of 1 lb. xanthone in sprays 3, 5, 7 and 8 or 3, 5 and 7, and 143–384 for DDT in sprays 2–7 or 1–8 with the addition of 1¼ lb. of a preparation (DN-111) containing 20 per cent. of a dicyclohexylamine salt of dinitro-o-cyclohexylphenol in sprays 3, 5 and 7 or 3, 5, 7 and 8. Eight sprays of 3 or 4 lb. lead arsenate and 2 lb. lime resulted in 369 mites per 100 leaves. None of the materials injured the trees, and control of *C. pomonella* was excellent in all but the plot receiving xanthone from the third cover spray onwards. Laboratory tests indicated that none of the additions greatly altered the initial toxicity of DDT deposits to young larvae of *C. pomonella*, with the exception of summer oil emulsion, which consistently reduced it when added at the rate of 3 or 6 quarts per 100 gals. In orchard tests, however, the reduction in efficiency against the larvae may be offset by the ovicidal value of the oil.

HEUBERGER (J. W.) & STEARNS (L. A.). **Compatibility of DDT and Fungicides on Potatoes.**—*J. econ. Ent.* **39** no. 2 pp. 267–268. Menasha, Wis., 1946.

The results are given of experiments in Delaware in 1944 and 1945 in which DDT, several organic fungicides and Bordeaux mixture were applied to potatoes attacked by *Empoasca fabae*, Harr., early blight (caused by *Alternaria solani*) or both. Five applications were made in the first case and six in each of the others, the amount of material applied increasing from 75 to 200 U.S. gals. per acre with the growth of the plants ; the DDT was used at a concentration of 12 oz. actual DDT per 100 U.S. gals. The results showed that DDT gave the same control of *Empoasca* and the same increase in yield whether used alone or in combination with the fungicides, that the fungicides gave the same control of *Alternaria* whether used alone or in combination with DDT, and that DDT did not control *Alternaria* [*cf. R.A.E.*, A **34** 224, etc.]. When *Empoasca* was present, plants treated with DDT, either alone or with a fungicide, were taller and broader and had larger and flatter leaflets than unsprayed plants or those treated with fungicides only, but this was not so in its absence, indicating that the Jassid has a serious effect on the plants. It is concluded that DDT gives excellent control of *E. fabae* and so results in increases in yield, and that it is compatible with several inorganic and organic fungicides and does not injure the plants.

HETRICK (L. A.). **The Control of the Cowpea Curculio.**—*J. econ. Ent.* **39** no. 2 pp. 268–269, 2 refs. Menasha, Wis., 1946.

Chalcodermus aeneus, Boh., causes considerable losses of cowpeas in gardens in Virginia in some seasons, particularly in the south-eastern counties, and investigations on its importance and control were begun in 1943. In 1945,

sprays containing 6 lb. per 100 U.S. gals. of wettable DDT (25 per cent.), sodium fluosilicate (97 per cent.), natural cryolite or basic copper arsenate, applied three times at intervals of a week, beginning when the first small pods were forming, at the rate of 2 U.S. gals. spray per 25 ft. of row, had no significant effect on yield, but all gave significant decreases in the infestation of pods, as compared with no treatment. Sodium fluosilicate reduced infestation more than cryolite and significantly more than DDT, but significantly less than basic copper arsenate. None of the insecticides damaged the plants, and plants sprayed with basic copper arsenate retained their leaves much better than the others, apparently because it acted as a fungicide and prevented early defoliation by a leaf-spot disease.

WILCOXON (F.). **Individual Comparisons of grouped Data by ranking Methods.**—*J. econ. Ent.* **39** no. 2 pp. 269-270, 2 refs. Menasha, Wis., 1946.

The author describes a method for comparing the effects of two treatments in an experiment comprising a series of replicates in groups of tests by assigning a numerical value to the effect of each treatment in each replicate, adding these values for each treatment in the whole experiment and calculating the significance of the figures obtained. As an illustration, he shows how the method was applied to an experiment comparing the values of two preparations of the same insecticide in which each was tested at three different concentrations with four replicates at each concentration.

SMITH (C. L.). **Two Industry Problems caused by Release of DDT.**—*J. econ. Ent.* **39** no. 2 pp. 270–271. Menasha, Wis., 1946.

The first problem discussed in this paper is the extent to which the sudden release of DDT for civilian use could be expected to reduce the demand for standard insecticides in the United States in 1946, and the second is that of labelling DDT and other organic insecticides for the protection of the public. It is pointed out that a number of hazards connected with the use of various organic chemicals cannot accurately be described as poisoning, and that the application of the ordinary label "Poison" to such chemicals is likely to result in its being disregarded with consequent accidents in their use. It has therefore been suggested that each warning label should show the risks and necessary precautions specific to the chemical in question.

NICKELS (C. B.). **DDT and Lead Arsenate compared for Control of the Pecan Nut Casebearer: 1945 Tests.**—*J. econ. Ent.* **39** no. 2 pp. 272-273. Menasha, Wis., 1946.

In further tests on the control of *Acrobasis caryae*, Grote, on pecan [*cf. R.A.E.*, A **35** 54], carried out in 1945 in an orchard with a medium infestation and a light nut crop in central Texas and in one with a heavy infestation and a large crop in southern Texas, single sprays were applied at a pressure of 500–600 lb. on 28th May and 26th April, respectively, when 41 and 21 per cent. of the first generation eggs had hatched. The results were estimated by the percentages of nuts retained in 50 clusters on 8-11 trees, in June, at the end of the feeding period of the first generation larvae, and at harvest, and the yield of nuts in lb. per sq. ft. of trunk section. In the orchard with a light crop, these figures were, respectively, 66·9, 40·7 and 21·8 for a spray containing 1½ lb. DDT, 1 U.S. pint glue and 2 U.S. quarts summer oil (a commercial emulsion containing 83 per cent. oil) per 100 U.S. gals., 59·9, 40·3 and 21·4 for one containing 6 lb. acid lead arsenate per 100 U.S. gals., and 42·4, 18·4 and 12·1 for no treatment. In the other orchard, they were 66·2, 46·8 and 68·8 for the lead-arsenate

spray, 74·4, 59·4 and 94·5 for a spray of 6 lb. lead arsenate, 13 fl. oz. nicotine sulphate and 3 U.S. quarts summer oil per 100 U.S. gals., 82·6, 61·7 and 114·9 for the spray of DDT, glue and oil and 81·3, 69·3 and 98·2 for one of 1 lb. DDT, 13 oz. nicotine sulphate, 1 U.S. pint glue and 2 U.S. quarts summer oil per 100 U.S. gals. Zinc sulphate (2 lb. per 100 U.S. gals.) was added to all sprays, primarily to control pecan rosette, but also to reduce the danger of arsenical scorching. It is concluded that a spray of 1½ lb. DDT is about as effective as one of 6 lb. lead arsenate in controlling a medium infestation, but that DDT is much more effective than lead arsenate and slightly better than a mixture of lead arsenate, nicotine sulphate and summer oil in the control of a severe infestation of the first generation.

Walton (R. R.). **Sabadilla and DDT to control the Squash Bug.**—*J. econ. Ent.* **39** no. 2 p. 273. Menasha, Wis., 1946.

The results are given of tests in Oklahoma to compare the efficiency against *Anasa tristis*, Deg., on squash of sabadilla dust, prepared by diluting a concentrate of sabadilla and lime with Pyrax (pyrophyllite) to give 5 and 10 per cent. sabadilla, Gesarol A-10 dust (10 per cent. DDT), alone or diluted with Pyrax to contain 5 per cent. DDT, and a pyrethrum dust (10 per cent. Pyrocide dust). In field-cage tests in which heavily infested small to medium plants were treated with about 1 oz. dust on 12th–18th July, the average mortality percentages, usually measured 64–72 hours after treatment, of nymphs of the first three instars, older nymphs and adults were 100, 99·4 and 96·9 for 10 per cent. sabadilla, 99·3, 92 and 76 for 5 per cent. sabadilla, 96·3, 60 and 60·1 for 5 per cent. DDT, and 84·9, 44·9 and 18·1 for the pyrethrum dust. In a laboratory test against adults, 10 per cent. sabadilla and 10 per cent. DDT gave mortalities increasing from 47·9 and 2 per cent., respectively, on the first day after treatment to 86 and 82·1 eight days after. Untreated bugs and those treated with the pyrethrum dust showed no mortality for three days and mortalities of 6 and 10·7 per cent. on the fourth day and 10·1 and 20·1 on the eighth. In field tests, the plants were dusted on 5th, 7th and 17th August with 10 per cent. sabadilla, 10 per cent. DDT or the pyrethrum dust, and the numbers of living bugs caught under sheets of heavy blotting paper beneath the plants were recorded at intervals of 2–4 days from 5th August to 3rd September. The numbers caught were considerably reduced by both sabadilla and DDT, but they increased again more rapidly for sabadilla after treatments ceased. The pyrethrum dust caused little reduction. It is concluded that if plants are thoroughly dusted, control can be obtained with dusts containing as little as 5 per cent. sabadilla and that DDT is less effective on the larger nymphs and adults during a period of 64–72 hours after treatment, but continues to kill the bugs for several days and ultimately gives effective control.

Jensen (D. D.) & Holdaway (F. G.). **DDT for Control of a Book Louse.**—*J. econ. Ent.* **39** no. 2 p. 274. Menasha, Wis., 1946.

In the course of investigations in Hawaii on the effect of DDT in protecting rabbit hides from attack by hide beetles [*Dermestes* spp.] [*cf. R.A.E.*, A **34** 274; **35** 68], hides of rabbits killed in February 1945 in Hawaii were dusted or sprayed with DDT while fresh and were then dried, wrapped in paper and stored in jars, the open ends of which were covered with white cloth. During storage some of them became infested by book lice, tentatively identified as *Liposcelis divinatorius*, Müll. No infestation was observed 21 or 41 days after treatment, but eggs, nymphs and adults were found after 170 days. The numbers of living nymphs and adults at this time on half of one side of one hide were 297, 158, 53 and 9 for hides treated with dusts containing 1, 3, 5 and 10 per cent. DDT, and 20, 0 and 0 for those treated with sprays of 1, 3

and 5 per cent. DDT in kerosene. No indication could be obtained of how severely untreated hides might have been infested by *Liposcelis* as they were almost completely destroyed by *Dermestes*.

HATCH (M. H.). *Hadrobregmus gibbicollis* **infesting Woodwork.**—*J. econ. Ent.* **39** no. 2 p. 274, 2 refs. Menasha, Wis., 1946.

The author records injury caused by *Hadrobregmus gibbicollis*, Lec., in Jefferson County, Washington, where the weathered spruce boards of the flooring of a porch were tunnelled by larvae and adults [*cf. R.A.E.*, A **27** 499], although some of the resulting destruction may have been due to fungi.

MUNRO (J. A.). **An early Use of Arsenic as an Insecticide.**—*J. econ. Ent.* **39** no. 2 p. 274. Menasha, Wis., 1946.

Reference is made to instructions by John Worlidge, published in 1681, for the control of ants in trees by the use of a bait of arsenic and honey in cardboard boxes pierced with holes large enough to admit the ants, but too small for bees.

CUTRIGHT (C. R.), VOGEL (M. A.) & PARKS (T. H.). **Basic Reasons for Difficulties in Codling Moth Control.**—*Bi-m. Bull. Ohio agric. Exp. Sta.* **30** no. 237 pp. 195–199. Wooster, Ohio, 1945.

Difficulty in controlling the codling moth [*Cydia pomonella*, L.] is usually due to the occurrence of weather favourable to it, its resistance to the spray materials used or faults in orchard practice and management.

In Ohio, temperatures above normal favour the moth in all stages of development and activity, but temperatures during May and June have an especially important influence on the activities of the first generation, and in heavily infested orchards the intervals between spray applications should be reduced from ten to seven days if temperatures average 4–6°F. above normal at this time. Temperatures so high that *C. pomonella* is adversely affected occur very rarely in Ohio. Other factors that favour the moth include the growing of apples over large areas, the retention of old trees and the planting of young orchards adjacent to old, heavily infested ones, the omission of spraying during the first few years of bearing, the interplanting of early and late varieties of apple and of stone fruits, which require different spray schedules, the growing of susceptible varieties, lack of pruning and neglect of orchard sanitation. Harvesting each variety as soon as it matures, removing infested fruit from the orchard when thinning, and destroying all the blossom or small fruits in years of partial crop or crop failure are useful control measures. Spraying may prove ineffective through the use of inadequate equipment, poor coverage, poor timing or the faulty use of materials.

It is concluded that although spraying is the chief method of controlling *C. pomonella*, supplementary measures should be carried out, particularly in young orchards.

MONRO (H. A. U.). **Low Temperature Fumigation.**—*Canad. Ent.* **77** no. 10 pp. 192–196, 10 refs. Guelph, Ont., 1946.

Fumigation for the control of insect pests at temperatures much below 60°F. has not been widely advocated. As the mean monthly temperatures in most of Canada are below 60°F. for eight or nine months of the year, the possibility of fumigating at temperatures lower than this is of great importance there. In a brief review of the theoretical aspects of the problem with reference to the literature, it is stated that though some of the most useful fumigants have

boiling points far above ordinary room or summer temperatures, they readily diffuse through packages once they are released in gaseous form and do not condense at concentrations used in fumigation, and it is shown that fumigants can be effective against insects at low temperatures [*R.A.E.*, A **23** 258; **25** 769; **28** 481], though further information is required on their mode of entry and toxic action. Most of the additional fumigant required under cold conditions is probably needed to overcome increased sorption of the gases by the commodities. There are few references in the literature to the successful use of fumigants at low temperatures, but Eichmann [**32** 268] reported that chlorpicrin, methyl bromide and hydrocyanic acid gas gave good results against the pea Bruchid [*Bruchus pisorum*, L.] in Washington at 12, 58 and 35°F., respectively. Residual odours of chlorpicrin remained in the peas for several days and caused eye irritation and nausea. Instructions issued in the United States for the control of the Japanese beetle [*Popillia japonica*, Newm.] permit the use of methyl bromide on potted plants and plants with bare roots for vault fumigation with circulating fans at temperatures as low as 38°F. The schedule of treatments calls for increasingly higher doses and longer exposure periods as temperatures decrease [*cf.* **31** 256].

In connection with the fumigation of imported broom corn in railway cars at atmospheric pressure [**32** 3], experiments were carried out in Montreal during February and March 1944 to estimate the dose of methyl bromide required for the control of overwintering larvae of *Pyrausta nubilalis*, Hb., at lower temperatures. The small, steel fumigation vault used had a capacity of 30 cu. ft., held one bale and was cooled by water with a temperature of 39°F. The specially constructed bales of broom corn weighed 80–108 lb. each and were 18 ins. in diameter and 36 ins. long. They were sorted outside for 24 hours before treatment, and larvae collected in Ontario in 1943 and stored in a cool dry room at 40°F. were placed in them six hours before fumigation, which lasted 16 hours. No fan circulation was used. The vault temperatures were between 40 and 50°F. Final mortality counts were made a week after exposure, and the mortalities given by various dosages at different bale temperatures are shown in a table. Complete mortality was effected at a bale temperature range of 40–46°F. with 1 lb. methyl bromide per 1,000 cu. ft., at 28–46° with 1·5 lb., at 29–42° with 2 lb., at 35–42° with 3 lb., at 14–27° with 4 lb. and at 2–26° with 7 lb. The methyl bromide was discharged into the vault almost entirely as a gas and directly above the bale. The importance of obtaining complete volatilisation during the entire period of treatment and proper distribution is emphasised. It is concluded that if this is done, insects can be killed at low temperatures provided that suitable modifications in dosage are made to overcome both increased sorption by the commodity and variations in the resistance of the insects.

ADAMS (J. B.). **Aphids on Canada wild Rice.**—*Canad. Ent.* **77** no. 10 p. 196. Guelph, Ont., 1946.

Rhopalosiphum prunifoliae, Fitch, was found in very large numbers on wild rice (*Zizania aquatica*) in New Brunswick in September 1945. Infested plants showed considerable damage to the foliage and head drop, undoubtedly due largely to the injury caused by the Aphids.

MCGUFFIN (W. C.). **New Descriptions of Larvae of Forest Insects: *Nyctobia*, *Eufidonia* (Lepidoptera, Geometridae).**—*Canad. Ent.* **77** no. 11 pp. 197–199, 2 figs., 2 refs. Guelph, Ont., 1946.

The larvae described in this part of a series on Canadian forest insects [*cf.* *R.A.E.*, A **34** 159] are those of *Nyctobia limitaria*, Wlk., and *Eufidonia*

notataria, Wlk., which are found on various conifers, and *E. discospilata*, Wlk., which attacks blueberry, *Kalmia* and birch. A description is also given of the egg of *N. limitaria*.

JACOBSON (L. A.). **The Effect of Say Stinkbug feeding on Wheat.**—*Canad. Ent.* **77** no. 11 p. 200. Guelph, Ont., 1946.

The Pentatomid, *Chlorochroa sayi*, Stål, frequently causes severe damage to wheat in various parts of western Canada [*cf. R.A.E.*, A **35** 97] by sucking the kernels so that they shrivel and both the yield and quality of the grain are reduced. Adults and nymphs are abundant on weeds in early spring and migrate to wheat when the ears form. A severe outbreak occurred at Turin, Alberta in 1941, and samples of threshed wheat from an infested field two miles long, of which the eastern end adjoined an abandoned field overgrown with Russian thistle [*Salsola*], were examined. In samples taken from the eastern end of the field and $\frac{1}{2}$, 1 and 2 miles to the west of it, 66·8, 40·2, 26·4 and 14·0 per cent. of the kernels were damaged and 59, 83, 95 and 97 per cent. germinated, respectively ; seed of which less than 90 per cent. germinates is unsatisfactory for planting. Although the weight per bushel, which was lowest (44 lb.) in the first sample, was almost the same (57–59 lb.) in the last three, the commercial grade was successively higher in each.

SWEETMAN (H. L.). **Further Data on the Value of Hand Control of the Tent Caterpillar, *Malacosoma americana* Fabr. (Lepidoptera, Lasiocampidae).**—*Canad. Ent.* **77** no. 11 pp. 202–203, 1 ref. Guelph, Ont., 1946.

A brief report is given of the successful control of *Malacosoma americana*, F., in a woodland plot at Amhurst, Massachusetts, during 1936–45 by destruction by hand of the newly hatched larvae [*cf. R.A.E.*, A **29** 395]. The number of colonies destroyed varied from year to year in accordance with immigration from the surrounding area ; during 1941–45, none was too far from the ground to be reached by hand. No colonies of the forest tent caterpillar [*M. disstria*, Hb.] were observed after 1938. It is concluded that the method is effective and economical.

COUTURIER (A.). **Observations sur un ennemi peu connu du haricot : la pyrale des haricots (*Etiella zinckenella* Treitschke. Lepidopt. Pyral).**—*C.R. Acad. Agric. Fr.* **29** no. 10 pp. 292–293, 3 refs. Paris, 1943.

Etiella zinckenella, Treitschke, attacks beans (*Phaseolus*) in France and is common in the Gironde, where the adults have been observed in May and July–September, but is not usually an important pest. In 1942, however, an outbreak severe enough to reduce yields occurred in fields near Bordeaux as a result of favourable conditions produced by an increase in the area under beans and dry weather continuing from late in 1941. Infestation was discovered at the end of July, when harvesting of the half-dry pods was begun, and 15 per cent. were found to be infested. Pods that were still green and in which the seeds were fairly large contained young larvae ; generally only one was present in each pod, but each fed on several seeds. Feeding was complete by August, when the larvae entered the soil and spun cocoons. Some pupated at once and gave rise to adults at the beginning of September, but most remained in diapause and would pupate in the following spring. Fields on gravel soils were heavily infested, but those on wet soils were free from attack. Some differences in varietal susceptibility were noted, since only 2·3 per cent. of the pods of one local variety were infested.

Suire (J.). **Attaque du soja par la pyrale des haricots : *Etiella zinckenella* Treitschke.**—*C.R. Acad. Agric. Fr.* **29** no. 10 pp. 293–294, 7 refs. Paris, 1943.

There appear to be no specific pests of soy bean in France, but an outbreak of *Etiella zinckenella*, Treitschke, occurred on this crop in the neighbourhood of Montpellier (Hérault) in September 1942, and the larvae also attacked soy bean about Toulouse. The author points out that the food-plants recorded in the older literature for *E. zinckenella* in France are *Spartium*, *Sarothamnus*, *Colutea* and *Robinia* and suggests that it has only recently attacked cultivated crops there. Previous observations at Bordeaux and Antibes, where it infested beans in 1936 and 1929, respectively, showed that it has two generations a year. Fully grown larvae are present in June–July and again in August–September in both the Gironde and the Alpes-Maritimes. A larva rarely consumes more than 4–5 seeds, but can move from pod to pod and even from plant to plant.

Nicolas (G.). **La pyrale du haricot dans la région toulousaine.**—*C.R. Acad. Agric. Fr.* **29** no. 18 pp. 495–496. Paris, 1943.

Larvae of *Etiella zinckenella*, Treitschke, were found to be infesting the pods of several varieties of soy bean harvested in September 1942 near Toulouse and severely damaged *Phaseolus* beans in 1943, aggravating the injury caused by prolonged drought.

Wilson (G. F.). **The Detection and Control of Garden Pests.**—$8\frac{3}{4} \times 5\frac{1}{2}$ ins., 194 pp., 54 pls. London, Crosby Lockwood & Son, Ltd., 1947. Price 12*s.* 6*d.*

This book contains descriptions of the types of damage caused by the various invertebrate pests, mostly insects, injurious to greenhouse and garden plants, including vegetables and fruit trees, in Britain, with notes on the appropriate measures of control, based on a series of articles that appeared in the horticultural press in 1932–36. The information is classified according to the nature of the damage and arranged in eight chapters each devoted to a different part of the plant ; an introductory chapter deals in a general manner with the characters of different classes of invertebrate pests, the life-histories and feeding habits of insects, the direct and indirect effects of insect feeding on plants, and various types of control measures.

Ruiz Castro (A.). **Fauna entomológica de la vid en España. Estudio sistemático-biológico de las especies de mayor importancia económica. II (Hemiptera). III (Diptera).** [The Insect Fauna of Grape-vines in Spain. Studies of the Systematics and Bionomics of the Species of major economic Importance. II (Hemiptera). III (Diptera).]—189 [+1] pp., 8 pls. (4 col.), 2 fldg. pls. (1 col.), 144 figs., 67 refs. ; 101 [+1] pp., 3 pls. (2 col.), 55 figs., 27 refs. Madrid, Inst. esp. Ent., 1944–45.

In these two further parts of a work on insects that attack grape-vines in Spain, the author treats the Hemiptera and the Diptera in the same way as he did the Lepidoptera [*cf. R.A.E.*, A **33** 298]. *Pseudococcus citri*, Risso, *Empoasca lybica*, Berg., and *Phylloxera* (*Peritymbia*) *vitifoliae*, Fitch, are the Hemiptera included, and *Ceratitis capitata*, Wied., the only species of Diptera.

Schneider-Orelli (O.). **Entomologisches Praktikum.** [A practical Course on Entomology.]—2nd revd. edn., 8 × 5¼ ins., 237 pp., 117 figs. Aarau, H. R. Sauerländer & Co., 1947. Price *Fr.* 10.

In this second enlarged edition of a handbook already noticed [*R.A.E.*, A **33** 379], the sections on the characteristics, classification and metamorphosis of insects and on methods of breeding them and studying other aspects of their biology have been rearranged and extended. The section on control measures has been modified to include recently developed insecticides and a chapter has been added on the biological testing of sprays and dusts.

Jarvis (H.) & Smith (J. H.). **Lucerne Pests.**—*Qd agric. J.* **62** pt. 2 pp. 79–89, 11 figs. Brisbane, 1946.

Notes are given on the bionomics and control of the chief pests of lucerne in Queensland. In some districts, particularly the northern ones, where lucerne is sown in warmer weather than elsewhere, partial or complete failure of young stands, usually in late autumn, may be caused by the larvae of *Euxoa radians*, Gn., *Agrotis ypsilon*, Hfn., and *Mocis* (*Remigia*) *frugalis*, F., which kill the seedlings by feeding on the leaves and on the stems below ground level. Eggs of *E. radians*, which is the most important of these cutworms, are laid in groups on the soil or on the stems and leaves of low-growing plants; the young larvae feed chiefly on the leaves of seedlings, while the older ones attack the stems below the soil and occasionally the foliage of well-established plants. They pupate in the soil after about four weeks, and adults emerge about two weeks later; there are several generations a year. In northern districts any weed-infested parts of the fields should be examined for cutworms before seed-beds are prepared, and, if necessary, a poison bait prepared by mixing 25 lb. bran with 1 lb. Paris green and adding 1 quart molasses in 7 quarts water should be distributed about a week before the seed is sown. Alternatively, the crop should be examined every 2–3 days during its first few months, and the bait applied (in late afternoon) as soon as cutworm activity becomes apparent.

Larvae of *Tortrix divulsana*, Wlk., occur on lucerne throughout the year, but seldom become injurious until just before flowering begins. They web the leaves into clusters in which they feed, and sometimes attack practically all the leaves in a field and cause faulty flowering and seed setting. The adults appear in numbers when the crop is half grown, and the eggs are laid in groups on the upper surfaces of the leaves; the larvae hatch in a few days, feed for 4–5 weeks and pupate in cocoons within their shelters, giving rise to adults about a week later. Damage is more serious in non-irrigated than in irrigated crops; in the former, competing weeds should be destroyed and the soil kept clear to permit the maximum utilisation of available rains. Where irrigation is available, the Tortricid should not be very injurious, provided that the lucerne is cut in the early stages of flowering. If a major attack occurs, the crop should be cut immediately or grazed judiciously until the pest becomes less active.

Outbreaks of Jassids, which are commonest during the spring and early summer, cause a reduction in the rate of growth and in the yield of hay. Severely injured crops are stunted and have little foliage, the loss of leaf being greater in non-irrigated than in irrigated fields. The Jassids most abundant on lucerne are *Empoasca alfalfae*, Evans, and *E. terrae-reginae*, Paoli. The eggs, which are laid in the upper part of the stem, the leaf stalks and the main veins of the leaves, hatch in about ten days and both nymphs and adults feed on the foliage; a white discoloration later appears at each feeding puncture. The development of the nymphs is completed in about two weeks during warm weather. When damage is extensive, the crop should be cut for hay or grazed, and the regrowth may then escape severe infestation if rain falls. Frequent applications of water will hasten the growth of infested crops

and minimise damage by distributing the insects over a greater number of leaves. Infestation originating in other crops can be offset to some extent by cutting the lucerne before it shows signs of serious injury. During spring and early summer, cutting should be adjusted to the state of infestation rather than to the state of growth of the crop.

Damage by *Heliothis armigera*, Hb., is less serious on lucerne than on its other food-plants [*cf.* *R.A.E.*, A **24** 71], although the larvae are very destructive at the flowering stage and reduce seed-production. Eggs are occasionally laid on non-flowering crops of lucerne, from which swarms of larvae sometimes invade other crops [*cf.* **35** 42]. Under favourable conditions the life-cycle is completed in four weeks, and there are at least five generations a year in coastal and sub-coastal districts; the spring and early summer generations are potentially the most harmful to lucerne. Should an outbreak occur the crop should immediately be cut for hay or grazed. Larvae of *Loxostege affinitalis*, Led. [*cf.* **25** 347], which are often found in association with *H. armigera*, can be controlled in the same way.

Damage by the Lamiid, *Zygrita diva*, Thoms. (crown borer), is usually confined to single plants in different parts of a field, and outbreaks are normally restricted to stands two or more years old. The eggs are presumably laid on or in the lower part of the stem, for young larvae have been found burrowing downwards through the pith. Larval development lasts three or more months, and pupation takes place in the end of the larval tunnel, from which the adult beetle cuts its way to the surface. There is probably only one generation a year, though larvae of different ages occur together in the same field. They have also been recorded from soy bean and the leguminous weeds, *Sesbania* and *Crotalaria*, in which their development takes place chiefly in the stem, though the feeding tunnel sometimes extends below ground level. If relatively large areas are affected, the lucerne should be ploughed under and another crop sown.

The viability of the seed is impaired by the Eurytomid, *Bruchophagus gibbus*, Boh., which completes its development in three weeks in summer. The adults appear in crops that have passed the flowering stage and insert their eggs into the developing seeds through punctures in the pods, and the larvae feed and pupate in the seeds. Precautions to be taken when lucerne is grown for seed include early cutting of the seed crop and the destruction of thresher screenings. Cutting before later-set pods are mature tends to give good quality seed that is reasonably free from injury. Cleaned seed should always be used for sowing.

Minor pests of lucerne include the Eumolpid, *Colaspoides foveiventris*, Lea, which feeds on the leaves, the Lycaenid, *Zizera* (*Zizina*) *labradus*, Godt., the larvae of which feed on the terminal growth and developing pods [*cf.* **30** 232], and the Coccid, *Steatococcus nudatus*, Mask., which forms dense colonies at the base of the stems and sometimes moves upwards into the leafier parts of the plants.

Papers noticed by Title only.

Wallace (C. R.). **Tests with Benzene Hexachloride and D.D.T. incorporated in the Soil for the Protection of Crop Plants from Black Beetle** [*Heteronychus sanctae-helenae*, Blanch., in New South Wales].—*J. Aust. Inst. agric. Sci.* **12** no. 3 pp. 96–102, 2 refs. Sydney, 1946. [For briefer account see *R.A.E.*, A **35** 218.]

La Ferla (A.). **Contributi alla conoscenza delle larve dei Curculionidi. I. *Sitona lineatus* L. II. Caratteri distintivi fra la larva di *Balaninus elephas* Gyllh. e quella di *B. nucum* L.** [Some Contributions to the Knowledge of the Larvae of Curculionids. I. *S. lineatus*, L. II. Characteristics distinguishing the Larvae of *Curculio* (*B.*) *elephas*, Gyllh. and *C.* (*B.*) *nucum*, L.]—*Boll. R. Lab. Ent. agr. Portici* **5** pp. 296–311, 10 figs. Portici, 1945.

NOTICES

ARREARS IN ABSTRACTING

Readers will have noticed that the abstracts have got somewhat into arrears in the past few years. This has been due to staff difficulties caused by the war, and the late arrival of many publications during the war followed by a rush of publications soon after the cessation of hostilities. Fresh staff has now been recruited, and is being trained, and arrears are being disposed of as rapidly as possible. It is hoped that all arrears will be made up by the end of 1948. Meanwhile, so that papers of very immediate importance should not be delayed until their normal turn, arrangements are being made with overseas countries for any such paper to be dealt with immediately.

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The importance of the use of films in research is becoming more and more recognised. A great number of research films, many of which would be of the greatest value to research workers, are in existence, but information concerning them is not readily available.

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Any information on record films that readers may care to give would be much appreciated by the Honorary Secretary, Scientific Film Association, 34, Soho Square, London, W.1.

If possible the following information should be included : a short description of the experiment recorded ; the date ; the name of the research worker who made the film ; the gauge and length ; if copies of the original record are available ; from whom the film is obtainable.

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CONTENTS.

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